THE ROCKEFELLER FOUNDATION

INTERNATIONAL HEALTH BOARD

SEVENTH ANNUAL REPORT
January 1, 1920—December 31, 1920

61 Broadway, New York, N. Y., U. S. A.
1921

INTERNATIONAL HEALTH BOARD

Report of the General Director

To the President of the Rockefeller Foundation:

Sir:—

I have the honor to submit herewith my report as General Director of the International Health Board for the period January 1, 1920, to December 31, 1920.

Respectfully yours,

WICKLIFFE ROSE,
General Director.

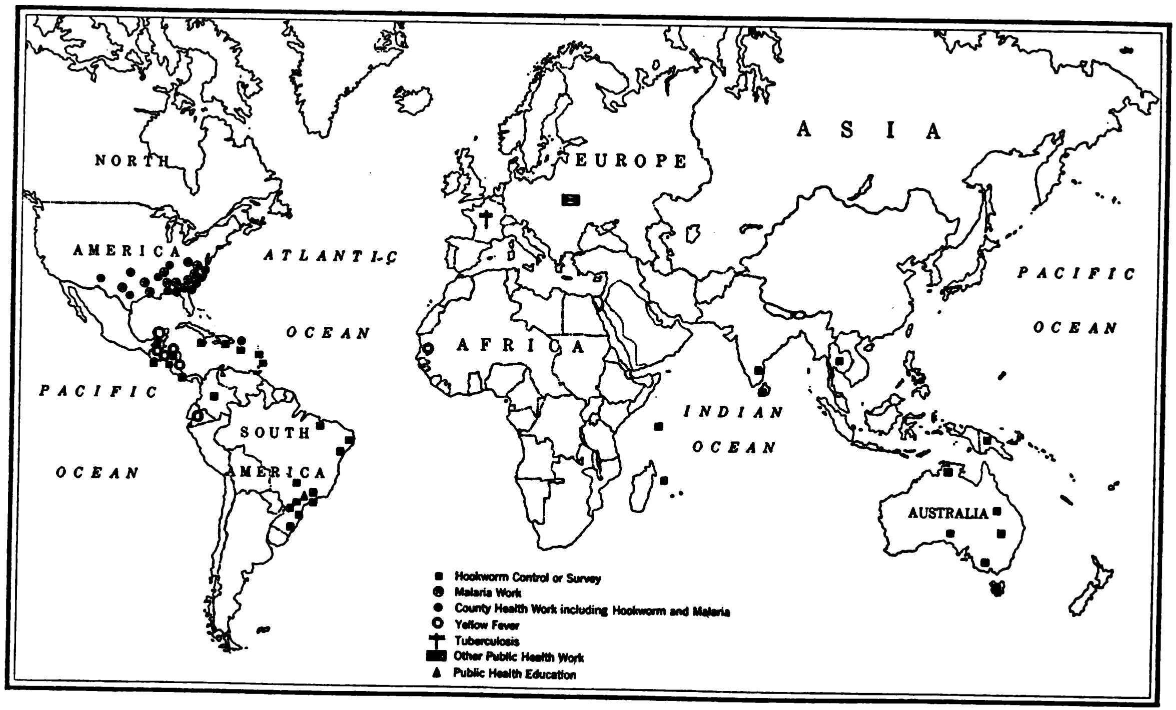

Fig. 1.—World map of activities of International Health Board during 1920

INTERNATIONAL HEALTH BOARD

OFFICERS AND MEMBERS

GEORGE E. VINCENT, *Chairman*
WICKLIFFE ROSE, *General Director*
HERMANN M. BIGGS
WALLACE BUTTRICK
SIMON FLEXNER
FREDERICK T. GATES
WILLIAM C. GORGAS[1]
EDWIN O. JORDAN
STARR J. MURPHY[2]
JOHN D. ROCKEFELLER, JR.
WILLIAM T. SEDGWICK[3]
VICTOR C. VAUGHAN
WILLIAM H. WELCH

EDWIN R. EMBREE, *Secretary*

[1] Deceased July 4, 1920.
[2] Deceased April 4, 1921.
[3] Deceased January 25, 1921.

PERSONNEL OF STAFFS DURING 1920[1]

ADMINISTRATIVE STAFF

WICKLIFFE ROSE, *General Director*

JOHN A. FERRELL, M.D., *Director for the United States*

VICTOR G. HEISER, M.D., *Director for the East*

HECTOR H. HOWARD, M.D., *Director for the West Indies*

L. W. HACKETT, M.D., *Associate Regional Director (for Brazil)*

ERNST C. MEYER, *Director of Surveys and Exhibits*

F. F. RUSSELL, M.D., *Director of Public Health Laboratory Service*

FIELD STAFF

HOOKWORM

AUSTRALIA	W. A. Sawyer S. M. Lambert[2]
BRAZIL	L. W. Hackett J. L. Hydrick
Bahia	F. L. Soper
Maranhão	F. L. Soper
Minas Geraes	G. K. Strode
Pernambuco	F. L. Soper
Rio Grande do Sul	Alan Gregg
Santa Catharina	Alan Gregg
CEYLON	W. P. Jacocks S. A. Winsor[2] C. H. Yeager G. G. Hampton
COLOMBIA	F. A. Miller

[1] Personnel employed by Government in co-operative work not listed.
[2] Special Staff Member.

Costa Rica	Louis Schapiro J. E. Elmendorf, Jr.
Guatemala	E. I. Vaughn[1]
India (Madras Presidency; survey)	G. P. Paul
Jamaica	P. B. Gardner (resigned) B. E. Washburn J. W. Visher (resigned)
Mauritius (survey)	J. F. Kendrick
Nicaragua	D. M. Molloy
Panama	F. A. Miller (transferred to Colombia) F. C. Caldwell
Porto Rico (survey)	J. B. Grant
St. Lucia	R. B. Hill (acting)
Salvador	C. A. Bailey
Santo Domingo (survey)	J. B. Grant
Seychelles	J. F. Kendrick
Siam	M. E. Barnes
Trinidad	G. C. Payne R. B. Hill W. C. Hausheer

COUNTY HEALTH WORK IN UNITED STATES

Alabama	F. W. Dershimer A. L. McKay
Kansas	A. J. Warren
Kentucky	P. W. Covington

[1] Special Staff Member.

New Mexico	D. B. Wilson F. H. Busby (resigned)
North Carolina	J. F. Docherty

MALARIA

Alabama	E. B. Johnson[1]
Arkansas	L. G. Hastings[1] William Ropes[1]
Louisiana	H. A. Taylor F. P. Gilbert[1] H. W. Green[1] F. E. Hulse[1] J. J. Mieldazis[1] L. J. Petritz
Mississippi	H. H. Howard C. C. Bass[1] J. L. Clarke[1]
Nicaragua	F. E. Hulse[1] D. M. Molloy
North Carolina	C. E. Buck[1]
Porto Rico	H. W. Green[1]
South Carolina	C. E. Buck[1]
Texas	E. H. Magoon[1] George Parker[1]
Virginia	E. H. Gage[1]

YELLOW FEVER

Yellow Fever Advisory Council[2]

Henry R. Carter, M.D., Assistant Surgeon General, United States Public Health Service

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[1] Special Staff Member.
[2] Not staff members; appointed to serve in an advisory capacity.

Juan Guteras, M.D., Director of Public Health, Cuba
Joseph H. White, M.D., Assistant Surgeon General, United States Public Health Service
Hideyo Noguchi, M.D., Rockefeller Institute for Medical Research

YELLOW FEVER COMMISSION TO THE WEST COAST OF AFRICA
W. C. Gorgas,[1] *Chairman* (deceased)
R. E. Noble, Assistant Surgeon General, U. S. A.
Juan Guiteras, Director of Public Health, Cuba
Adrian Stokes, Assistant to Professor of Pathology, Trinity College, Dublin
A. E. Horn, West African Medical Service
W. F. Tytler, Member of Staff of Medical Research Council, London

MEXICO AND CENTRAL AMERICA	T. C. Lyster
ECUADOR	M. E. Connor
GUATEMALA	E. I. Vaughn[1] H. K. Marshall[1]
MEXICO	M. E. Connor B. W. Caldwell[1] I. J. Kligler Hideyo Noguchi
NICARAGUA	D. M. Molloy
SALVADOR	C. A. Bailey W. H. Davies[1]

TUBERCULOSIS

TUBERCULOSIS IN FRANCE
L. R. Williams,[1] *Director*
B. L. Wyatt[1]
S. M. Gunn[1]
Alexandre Bruno[1]
F. Elisabeth Crowell[1]

[1] Special Staff Member.

SPECIAL

School of Hygiene and Public Health, São Paulo

S. T. Darling,[1] *Professor of Hygiene and Director of Laboratory*
W. G. Smillie, *Assistant Professor of Hygiene*
G. H. de Paulo Souza[1]
F. Borges Vieira[1]

Public Health Administration, Czechoslovakia

S. M. Gunn[1]

ON LEAVE

W. T. Burres
S. T. Darling[1]

AT HOME OFFICE

C. W. Wells (in charge of fellowships)

IN TRAINING

Alabama	A. L. McKay, M.D.
Arkansas	William Ropes[1]
Costa Rica	J. E. Elmendorf, Jr.
Louisiana	F. E. Hulse[1] L. J. Petritz
Mississippi and Ceylon	G. G. Hampton
Mississippi and Trinidad	W. C. Hausheer
New Mexico	F. H. Busby (resigned)
North Carolina	J. F. Docherty
North Carolina and New Mexico	D. B. Wilson

[1] Special Staff Member.

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ILLUSTRATIONS

OPERATIONS IN BRIEF

In the development of medicine emphasis is shifting from cure to prevention. Despite the fact of world-wide financial depression the year has been one of encouraging progress in public health. Government appropriations have been increased. New services involving continuing expenditures have been created and men are being trained for their administration. In response to the appeal of opportunities far in excess of its resources the Board has shared in an increasing number of projects in something more than fifty states and countries throughout the world.

Promoting Health in Many Lands

The Board brought its tuberculosis work in France well within sight of the completion of its transfer to the French by the end of 1922; took up the fight against yellow fever in Mexico; continued it in Guatemala, Honduras, Nicaragua, and Salvador; brought to successful conclusion the effort to free Guayaquil and Ecuador of the infection, and sent a yellow fever commission to West Africa to make a preliminary study of the situation; joined forces with federal, state, and local authorities in a series of demonstrations in

malaria control by anti-mosquito measures in ten southern states; made a study of conditions in Argentina, Porto Rico, and Nicaragua with a view to extending its work in malaria control to tropical regions; pushed the fight against hookworm disease as a means of creating popular interest in public health under forty-two governments distributed over the more heavily infected regions; carried out a series of scientific studies yielding significant results in the fields of hookworm disease and malaria control; aided in the development of a rural county health service in twelve states; co-operated with the new ministry in developing public health administration in Czechoslovakia; assisted four state and national departments of health in establishing or further developing their public health laboratory service; and contributed toward the development of schools of hygiene at Prague and at São Paulo, Brazil, aided state boards of health in maintaining intensive short courses for workers in the service, and provided fellowships in public health for thirty-four selected students from ten countries. The object and effect of the effort in all countries have been to create popular sentiment in support of public health, to increase appropriations for health purposes, and to promote the development of permanent agencies for the control of disease, the cultivation of

hygiene as a science, and the training of men for public health service.

Fighting Yellow Fever

Yellow fever, ignoring as it does political boundary lines and disturbing directly or indirectly the commerce of all nations, presents a particularly strong appeal for concerted effort on an international scale. During the year 1920 operations against the disease were in progress in all infected areas: on the east coast of Brazil; in Ecuador and Peru; in Guatemala, Honduras, Nicaragua, and Salvador; in Mexico; and in West Africa.

In Brazil. The infected area in Brazil is being steadily reduced. Extending in former

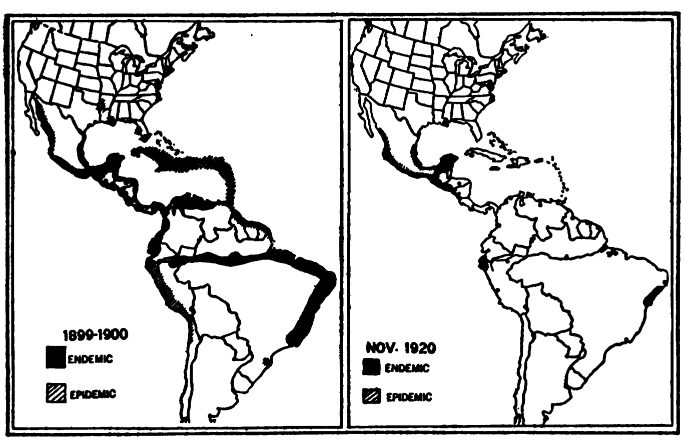


Fig. 2.—Result of twenty years' war on yellow fever. Few endemic or epidemic centers remain in the Western Hemisphere

years from Rio de Janeiro along the east coast to the mouth of the Amazon river and up the Amazon valley to Iquitos in Peru, the disease is now confined to a narrow coastal strip from Pernambuco to Bahia. These two ports are suspected as endemic foci from which the infection spreads from time to time to the surrounding regions. A number of sporadic outbreaks early in the year were promptly extinguished. The situation would seem to call for an organized attack on the breeding places of the Stegomyia mosquito throughout the danger zone, with special concentration of effort on the two strategic centers: Pernambuco and Bahia. Operations are under the Brazilian National Department of Health, which has made available ample funds for the purpose.

In Ecuador. Yellow fever quarantine against Guayaquil, for more than seventy-five years a dreaded seed-bed of infection, has been lifted. Control measures were inaugurated in November, 1918. Effort was centered on the breeding places of the Stegomyia. As the mosquito index was lowered the case rate fell rapidly from eighty-eight in December, 1918, to two in May, 1919, since which time no case has been reported from Guayaquil or Ecuador. After more than a year of continued mosquito control dating from the last reported case of yellow fever, Gov-

Fig. 3.—The late Major General William Crawford Gorgas. At the time of his death General Gorgas was Director of the Yellow Fever Commission of the International Health Board

A TRIBUTE TO GENERAL GORGAS

By William H. Welch, M.D.

The following minute from the pen of Dr. William H. Welch was incorporated in the records of the International Health Board at its meeting on May 24, 1921:

Major General William Crawford Gorgas, a member of the International Health Board and the Director of its Yellow Fever Commission, died in London July 4, 1920, while on his way to the west coast of Africa to investigate the prevalence and importance of yellow fever in that region.

General Gorgas, by the conquest of yellow fever in Havana and the control of this and other pestilential diseases on the isthmus of Panama, had won world-wide recognition as a sanitary administrator. American and European countries alike sought his advice and services for the control of endemic and epidemic diseases. One of the most important of his foreign missions was to the Transvaal, where the measures he recommended resulted in markedly reducing the high mortality rate of pneumonia.

In January, 1914, General Gorgas became Surgeon General of the United States Army, and in 1915, in recognition of his work in sanitating the Canal Zone, he was created Major General by special act of Congress. Throughout the period of the World War he served as Surgeon General of the United States Army. The confidence reposed in him by the army, the medical profession, and the general public did much to enhance the value of his services in protecting the health of the American troops.

Years before his death his investigations and experiences with yellow fever had convinced him that in the Western Hemisphere the disease was kept alive by its prevalence in a few endemic foci. By means of a successful attack on the disease in these foci he considered it feasible to eliminate the infection from the New World. The stamping out of the disease in Guayaquil, and the encouraging prospect of controlling the infection in other parts of South America and in Central America, fully justify this faith of General Gorgas.

It is not too much to state that the results accomplished through the administrative genius of Gorgas, coupled with the scientific discoveries of others—notably those of Walter Reed and his colleagues on the United States Army Yellow Fever Commission—have repaid many times over all the money that has been expended for the support of scientific research. Their work has resulted in saving untold thousands of human lives and much treasure, in protecting the American sea-coasts from the invasion of a dreadful scourge, in the construction of the Isthmian Canal through a pestilential zone transformed into one of the most healthful on the globe, and in reclaiming for civilization many pest-ridden regions in tropical countries throughout the world.

The genial, kindly qualities of General Gorgas endeared him to all his associates. To his colleagues on the Board the memory of him and of his achievements will always remain a cherished inspiration.

ernment declared the country free of infection and on December 1 the Board's representative was withdrawn. The local authorities are continuing operations as a precaution against the re-introduction of infection from Peru.

In Peru. Early in the year 1919 an extensive epidemic of yellow fever broke out in the department of Piura, just across the Ecuadorian border in northern Peru, and in twelve months had spread unchecked over a considerable area. The epidemic numbered more than 3,000 cases, with from 500 to 600 deaths. Mosquito control undertaken by Government in 1920 and carried out under the direction of Dr. Henry R. Carter, of the United States Public Health Service, resulted in the epidemic being promptly suppressed. Dr. Noguchi, of the Rockefeller Institute for Medical Research, visited the region during the outbreak and further confirmed his earlier findings in Guayaquil and Mexico by isolating from the blood of yellow fever patients the *Leptospira icteroides*.

Before the infection had been stamped out in Piura it had been carried into the department of Lambayeque to the south and was not discovered until it had again spread over a considerable region. Late reports indicate that it is still making headway. In response to invitation by Government the Board has contributed toward

the maintenance of control measures which are now being organized by Dr. Henry Hanson under the National Department of Health.

In Mexico and Central America. Merida, Yucatan, has been regarded for years as an important endemic focus of yellow fever. Authorities have been disposed to refer to it as the seed-bed from which the infection has been carried from time to time throughout Mexico and Central America. From some source outbreaks have occurred during the last two years in eastern and western Mexico, Guatemala, Honduras, Nicaragua, and Salvador. Operations covering this entire region are now being carried out under unified administration. In each of these countries Government has created under its national department of health a yellow fever commission. By executive decree these commissions have been given full authority to deal with the situation. The simple device of giving the Board representation on each of the commissions has effected concert of effort. Recent reports indicate a steadily falling mosquito index and a corresponding drop in case reports. In view of the vast extent of the area to be covered effort is being centered on strategic points, and particularly on Merida as the key to the situation.

Commission to Africa

The objects of the commission to West Africa were two: (1) to determine whether the reported yellow fever in that region is yellow fever; and (2) to ascertain, if the presence of yellow fever should be confirmed, whether control measures were feasible. The commission sailed from London June 30; visited the Belgian Congo, Dahomey, Gold Coast, Northern Nigeria, Senegal, Sierra Leone, and Southern Nigeria; and submitted its report in New York December 2. No authentic case of yellow fever was seen. Conferences and a study of records, however, gave strong indication of the presence of the infection within recent years. The region of suspected infection is vast, travel is difficult, and living conditions are extremely primitive. And to these must be added the deeply rooted native tradition to conceal all cases of sickness. The control of yellow fever, however, even under these trying conditions, is regarded as not altogether impracticable. The commission recommends that the report be accepted merely as a progress report and that another commission be sent out, equipped for a more extensive and prolonged investigation of the situation, including a laboratory study of the suspected fevers of the region.

Yellow Fever Vaccine and Serum

Killed cultures of *Leptospira icteroides* were first prepared and used by Noguchi for protective inoculation against yellow fever in Guayaquil in 1918, with suggestive results. The vaccine has been used on a considerable scale in Mexico and Central America with results which seem to support the earlier indications. A therapeutic serum prepared by Noguchi is also available for the treatment of yellow fever. The use of this serum given in the early days of the disease in a limited number of cases seemed to reduce the usual yellow fever mortality of 50 to 60 per cent to 9 per cent. These products are being supplied to government authorities in Mexico, the Central American countries, Peru, and Brazil. It is to be borne in mind, nevertheless, that the vaccine, however valuable as a protection to the individual, is *not* a substitute for thoroughgoing mosquito control.

Crusade Against Tuberculosis in France

In 1917 the Board joined forces with Government and the people of France in a national crusade against tuberculosis. For three years the French had borne the brunt of war; the tuberculosis rate was supposed to be high and to be on

Fig. 4.—History taking in clinic work. Campaign against tuberculosis. France

Fig. 5.—Traveling unit used by Educational Division, Commission for Prevention of Tuberculosis in France

the increase; there were in the country but twenty-two tuberculosis dispensaries, and for tubercular cases, military and civilian, not more than 8,000 beds. The situation as viewed by the authorities called for energetic measures.

After conference with French officials and a study of the situation on the ground, operations were organized under a Commission for the Prevention of Tuberculosis in France. The Commission, working at all times in co-operation with the French and with steadily increasing French personnel, undertook to encourage the establishment of tuberculosis dispensaries; to develop centers for the training of visiting nurses; to provide graduate instruction for physicians to prepare them for medical service in connection with the dispensaries; to conduct an energetic educational campaign on a national scale; and to focus all activities in two concrete demonstrations—one comprising a typical congested city arrondissement in Paris, the other the rural de-

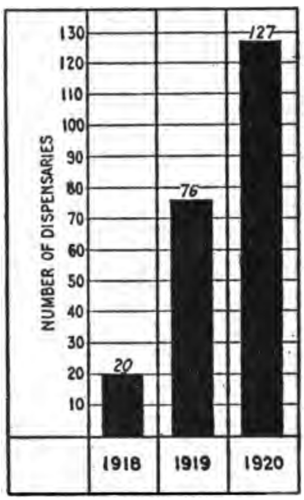


Fig. 6.—Tuberculosis dispensaries functioning in France through initiative of Bureau of Departmental Organization, 1918–1920

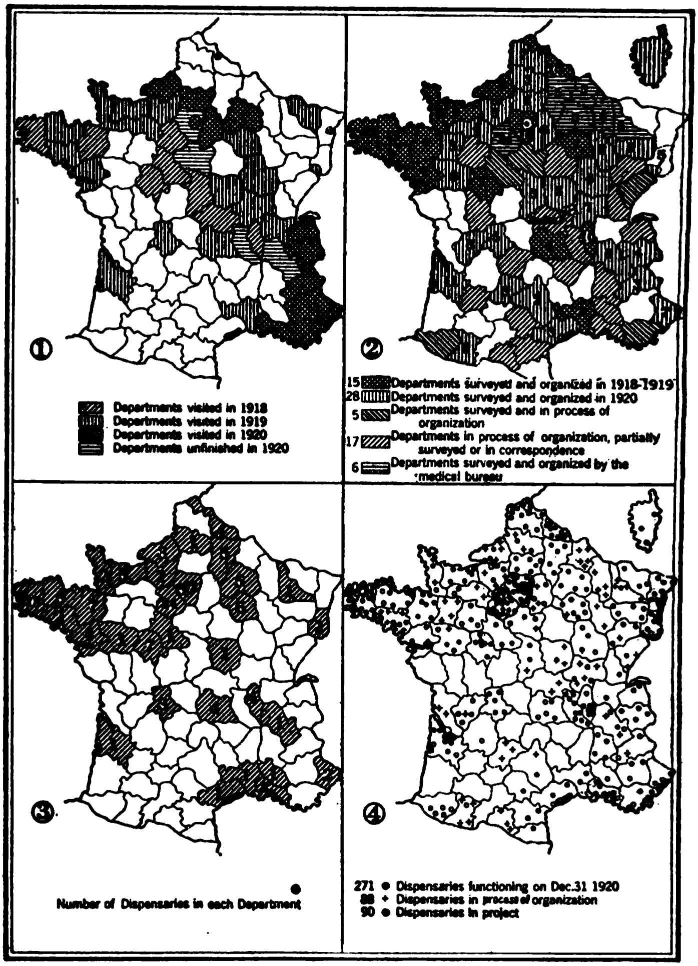


Fig. 7.—Organization and activities of Commission for the Prevention of Tuberculosis in France. 1. Work of educational division, showing departments visited by traveling exhibits during 1918, 1919, and 1920; 2. Work of division of departmental organization, showing departments in which anti-tuberculosis organization has been effected or is in progress; 3. Number of tuberculosis dispensaries in each department co-operationg with the Commission on December 31, 1920; and 4. Total number of tuberculosis dispensaries functioning, in process of organization, or in project at the end of 1920

partment of Eure-et-Loir. Mobile educational exhibits have covered systematically twenty-eight departments; departmental organization, including dispensaries and provision of hospital beds, has been completed in twenty-one departments; seven centers are in operation for the training of public health visitors, and plans have been matured for the establishment of three—possibly four—permanent training schools; diplomas have been granted to 215 women completing the course. The short courses for physicians have been successful beyond expectations. A sustaining popular sentiment has been created, and Government agencies, national and local, are committed to the task. The National Committee of Defense against Tuberculosis has been organized for the ultimate direction of the work. Present plans provide for completion of the transfer of responsibility to French agencies by the end of 1922.

Team-Play in Malaria Control

A series of field experiments conducted in a group of small towns in southwestern Arkansas during the years 1916-1919 had yielded encouraging results. Similar measures had been applied by the Federal Government in the cantonment zones and a number of small communities in

many parts of the South. It had been shown that in towns—even small towns of 1,000 to 1,500 inhabitants—under average conditions in the Southern States, malaria can be controlled within limits of cost which such communities may well afford. Conditions seemed to invite a joint undertaking on a larger scale with a view to driving this fact home to the people throughout the more heavily infected region. Early in the year 1920 the United States Public Health Service, the state departments of health, and the Board entered into an arrangement by which demonstrations in malaria control were carried out in fifty-two towns in ten southern states. The local communities provided a liberal share of maintenance costs. Effort was centered on the breeding places of mosquitoes. The measures employed were simple drainage, filling borrow pits and shallow pools, channeling streams, clear-

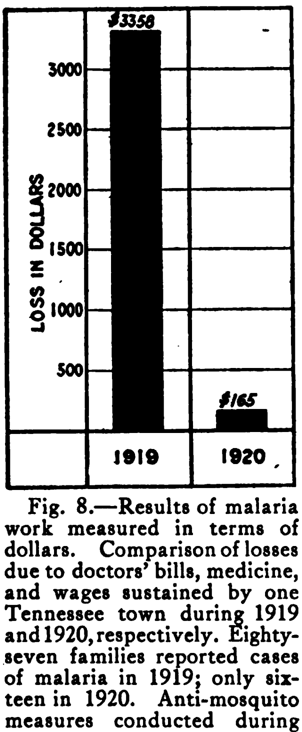


Fig. 8.—Results of malaria work measured in terms of dollars. Comparison of losses due to doctors' bills, medicine, and wages sustained by one Tennessee town during 1919 and 1920, respectively. Eighty-seven families reported cases of malaria in 1919; only sixteen in 1920. Anti-mosquito measures conducted during 1920 cost the town a total of only $1,847.75.

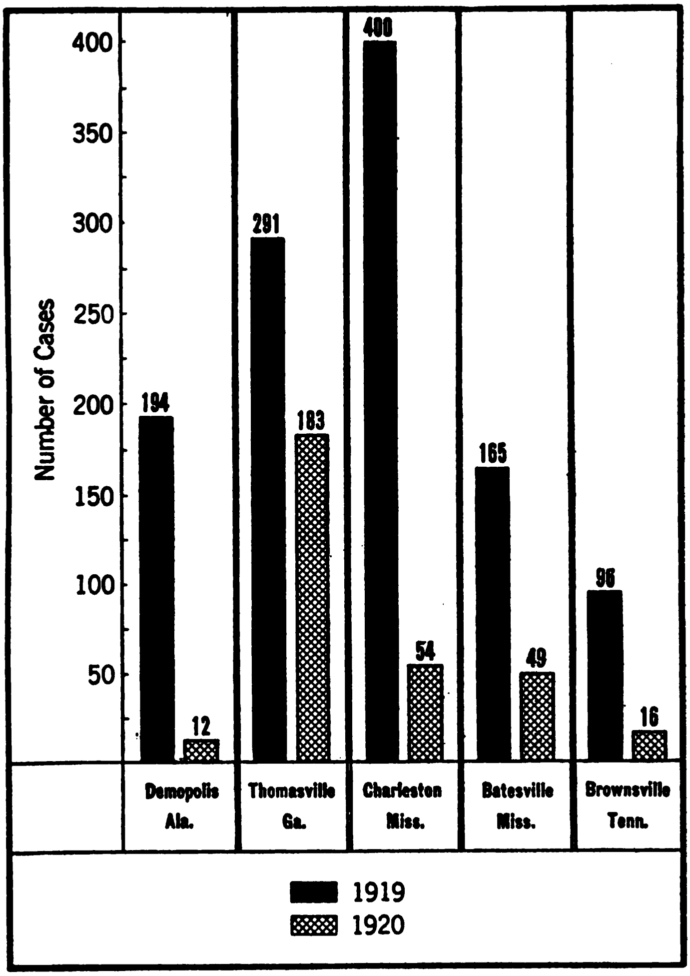
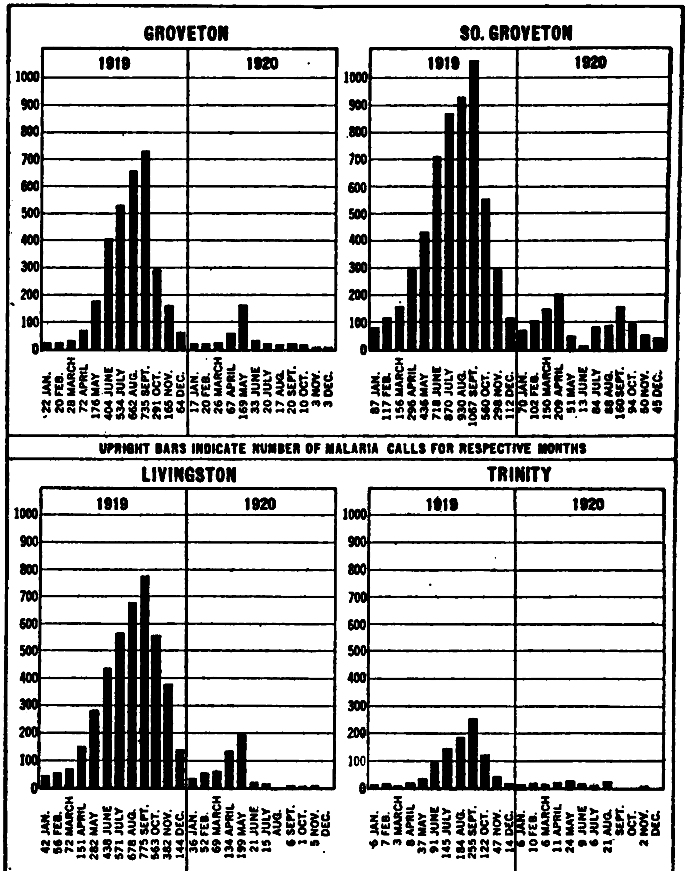


Fig. 9.—Reduction in cases of malaria in five Southern towns where anti-mosquito operations were conducted in 1920 (figures based on physicians' cases). Work was conducted in fifty-two towns, but comparative records of malaria incidence for 1919 and 1920 are not available for all. (See also Fig. 10.)



		GROVETON	SO. GROVETON	LIVINGSTON	TRINITY
POPULATION		1200	1300	1250	1250
Calls for Malaria	1919	3173	5647	4154	919
	1920	405	1116	538	95
Per Capita Cost	1920	.27	.23	.23	.35

Fig. 10.—Malaria control by anti-mosquito measures in four Texas towns (based on physicians' calls for 1919 and 1920). Control effort began April 1, 1920. (See also Fig. 9.)

ing the margins of streams and ponds, removing obstructions, turning in the sunlight, oiling, and enlisting the services of the top minnow. Typical results are exhibited in Figs. 9 and 10. The average per capita cost for the fifty-two towns was 78¢ per annum. The records show that such communities having a reasonably heavy infection may free themselves of malaria and of the mosquito as a pest for less than malaria is costing in doctors' bills alone.

Mosquito Control in a Rural Community

Malaria, however, is a rural disease also. In most infected regions it bears with greatest severity upon the people who cultivate the soil. In 1918 the Board undertook a three-year experiment to test the feasibility of mosquito control in a typical community of scattered farm homes. The area selected was in Hinds county, Mississippi. After one year devoted to a study of the field, a systematic attack was made on the breeding places within one fourth mile of each home. Oil and the top minnow were the principal weapons employed. The results were a further demonstration of the efficiency of the top minnow and a reduction of 77 per cent in malaria incidence at a per capita cost of $2.60 for 1919 and of $3.09 for 1920.

Fighting Mosquitoes With Fish

The outstanding feature of the experiment in Hinds county was the use of the top minnow (*Gambusia affinis*) as principal agent in the control of Anopheles breeding. The fish were procured from a large pond within the community; they were easily transported, multiplied rapidly, wintered well, and were tremendously effective in devouring mosquito eggs and larvae. Wherever conditions favored their use, they demonstrated important advantages over oil: the original cost represented only the slight labor of transportation; they were relatively permanent, only a few places requiring occasional re-stocking; they were unaffected by rain or wind; and were effective in many breeding places, as in stock ponds and certain running-streams, where oil could not be applied. In 89 per cent of the water deposits within the area in 1919, and in 85 per cent in

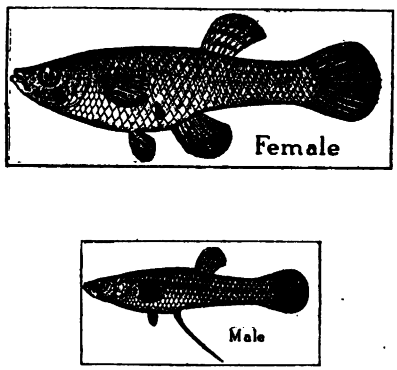


Fig. 11.—Top minnows (*Gambusia affinis*); actual size. These fish reduce the incidence of malaria in control areas by devouring mosquito larvae, which are their favored food

Fig. 12.—Type of ditch to carry off drain water and prevent mosquito breeding. Malaria control operations, Southern States

Fig. 13.—Ditching gang at work. Malaria control by anti-mosquito measures, Southern States

1920, mosquito breeding was kept under complete control by the use of the top minnow alone.

Fish were enlisted in 1920 in the fight against malaria in towns. At Canton, Mississippi, the top minnow effected complete control in 86 per cent of the breeding places; at Athens, Texas, 70 per cent reduction in malaria incidence was achieved through the use of fish alone. Dr. Connor used fish as an important agent in freeing Guayaquil of yellow fever; Le Prince of the United States Public Health Service, demonstrated their effectiveness in Tampico; and they are now being enlisted in the war on yellow fever throughout the infected region in Mexico, Central America, and Peru.

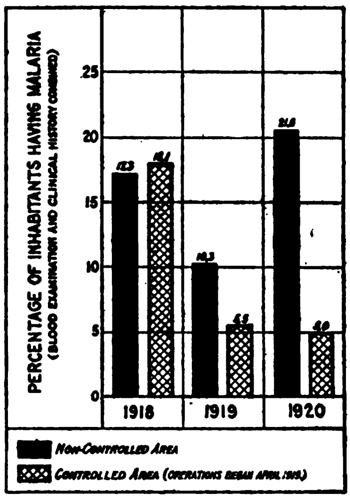


Fig. 14.—Malaria control by anti-mosquito measures, Hinds county, Mississippi, 1919 and 1920. Rate of clinical malaria in controlled area compared with that in non-controlled area. (Note decline of malarial incidence in controlled area despite fluctuation in non-controlled area)

Malaria Control by the Use of Quinine

Theoretically it should be possible to prevent the spread of malaria by an attack on the para-

site in the blood of the human host. Every mosquito that carries malaria has derived its infection from the blood of an infected person. If the blood of all infected persons in a community were freed of the parasite, malaria should disappear. By field experiment on a large scale Dr. C. C. Bass has shown that in the Mississippi delta, ten grains of quinine a day for eight weeks kills the parasites in the blood of about 90 per cent of the cases treated. Effort has been made to apply the principle in a selected area in Sunflower county. In 1918 the area, comprising 100 square miles and 9,000 inhabitants, was worked intensively by house-to-house visit. All persons shown by blood examination to be infected, and those giving a history of an attack of malaria within twelve months, were given the standard treatment. Quinine was furnished free. During 1919 and 1920 the drug was provided in convenient form at cost. To plantation managers, physicians, and the people living within the area, reduction in malaria incidence has been obvious. It has been difficult, however, to get a definite statistical measurement of results. By the best estimate available the malaria incidence has been lowered from 40 per cent in 1917 to 18 per cent in 1920. The per capita cost has been: for 1918, $1.08; for 1919, $1.09; and for 1920, $0.38.

The treatment employed by Bass in this field experiment has been endorsed by the United States Public Health Service and the National Malaria Committee, and is being adopted by physicians in their practice. Arrangements have recently been made whereby a commercial agency will supply quinine put up in standard treatment form to stores throughout all malarious communities of the Southern States where the sale of the drug is encouraged by state and local health authorities. This arrangement, by enabling persons desiring quinine treatment to secure it at stores for about half the usual price, will make it unnecessary for health agencies to provide funds for quinine distribution.

Promoting Public Health Through Hookworm Control

Hookworm is one of the most serious of the disabling diseases of man. It is not for this reason, however, that the Board has selected it for so large a share in its scheme of operations. Its control, easily justifiable on its own account, is much more important as a means to a larger end. The disease lends itself readily to purposes of demonstration. It affects fundamentally the welfare of mankind over vast regions, and yet in its cause, its cure, its mode of transmission and means of prevention, it is so

simple and tangible that the layman—even the illiterate—may be made to see and understand it. Demonstrations in the control of this one disease, while bringing relief to hundreds of thousands of suffering people and increasing the economic efficiency of communities and countries, are having a more important effect in creating a popular interest in public health and in promoting the development of permanent agencies for the control of this and other preventable diseases.

With this object in view, control operations were continued or undertaken during the year in nine southern states and twenty-five foreign states and countries;[1] and infection surveys were carried out in whole or in part in Madras presidency, India; in the islands of Porto Rico, Santo Domingo, and Mauritius; in Colombia; in limited areas of South Australia, Victoria, Tasmania, Northern Territory, New South Wales, and Queensland, Australia; and in the states of Bahia, Pernambuco, Maranhão, Santa Catharina, and Rio Grande do Sul, Brazil.

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[1] **Southern States:** Alabama, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee, Texas, and Virginia; **West Indies:** Jamaica, Porto Rico, St. Lucia, and Trinidad; **Central America:** Costa Rica, Guatemala, Nicaragua, Panama, and Salvador; **South America:** the Federal District and the states of Bahia, Maranhão, Minas Geraes, Parana, Pernambuco, Rio de Janeiro, Rio Grande do Sul, São Paulo, and Santa Catharina in Brazil; and Colombia; **The East:** Ceylon, Papua, Queensland, Seychelles, and Siam.

Nearing the Goal in the Southern States

Operations in the Southern States for the past ten years illustrate the principle above set forth. In 1910-1911 the Rockefeller Sanitary Commission entered into joint arrangement with eleven states for the relief and control of hookworm disease. Five years later the unfinished labors of the Commission were taken over by the International Health Board and have been continued to the present. The time has now arrived when one may say the object which the Commission had in mind has been accomplished, and the arrangement, so far as this disease is concerned, may be brought to a satisfactory close.

These states have not been freed of hookworm. Far from it. The accomplishment of that result, it was understood and stated in the beginning, is a thing that no outside commission could do if it would and that no such organization should do if it could. This is a work for permanent agencies operating over long periods of time. Nevertheless, the object which the Commission set out to accomplish has been achieved. The disease has been greatly reduced in both severity and prevalence; the people have been enlightened as to its importance, its relief, and the means of its final control; permanent agencies rooted in the soil are committed to the task; and

a sustaining public sentiment has been created in the interest of more general measures for the better protection of health. Legislative appropriations for public health purposes have increased during the ten years more than 500 per

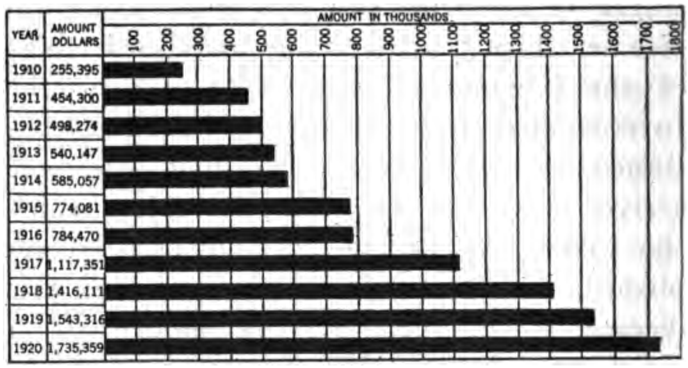

Fig. 15.—Appropriations of legislatures to State Boards of Health in eleven Southern States. 1910–1920. Funds for anti-tuberculosis work included

cent. Full-time county organization is being rapidly developed and measures against hookworm are being absorbed in more general schemes of disease control. In short, the foundation has been laid in these states for a tax-supported health service, state and local, which may be depended upon in the end for the control of hookworm and other preventable diseases.

Comradeship with the states in this service has been an inspiring privilege. Withdrawal from participation in measures directed specifically against this one disease does not terminate or

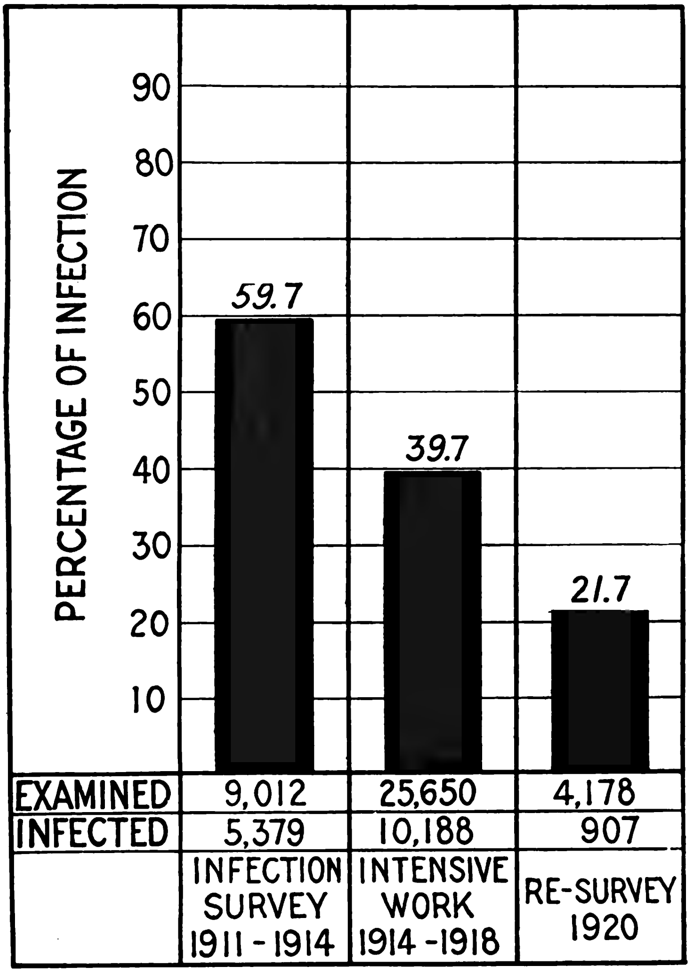

Fig. 16.—Decline in hookworm incidence among school children in Southern States during ten-year period, 1911 to 1920. Based on examination of 38,840 cases in twelve counties

Fig. 17.—Carrying the gospel of sanitation to native peoples. Attendance at lecture on hookworm disease. Village of Gamilababa, Trobriand Islands, Papua

disturb this relationship. It makes possible rather the transfer of effort to what have come to be the more strategic points in the general scheme of development. These are for the present malaria control, the county health service, and the training of personnel for the services that are being created.

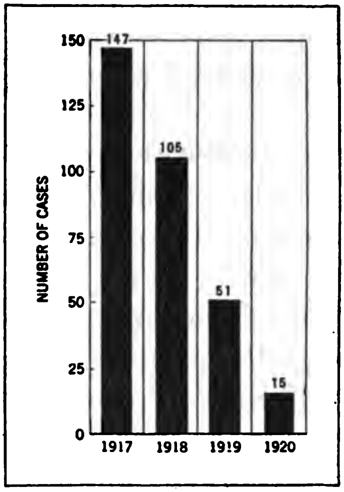

Fig. 18.—Decline in cases of typhoid fever, Monroe county, Mississippi, 1917 to 1920. Measures against typhoid fever constitute an important feature of county health work

Resuming Operations in the West Indies

During the war it became necessary on account of shortage in personnel to discontinue active measures against hookworm in three colonies of this group. Operations are now in progress in Trinidad, St. Lucia, Jamaica, and Porto Rico, with preparations under way for re-opening the work in Dutch Guiana, British Guiana, and Grenada. In all these countries government has undertaken to establish and maintain a system of soil sanitation well in advance of the mobile clinics which follow with an organized scheme of in-

tensive treatment and education. The outstanding features of recent development have been a slow but steady growth in Government support; conspicuous advance, particularly in Trinidad and Jamaica, in sanitation; and an appreciable movement in the direction of a more general scheme of public health.

Government Assuming the Burden in Brazil

In Brazil official agencies are taking over the burden of hookworm control and are going forward with great energy in the development of a general program of public health. In the autumn of 1916 operations were opened in this country with an infection survey followed by a demonstration in the state of Rio. After this first demonstration, for which the Board provided the funds, the service was rapidly extended on the basis of increasing government support to the Federal District and nine states. Response on the part of officials and the people has been hearty. Within four years the influence of the work has reached the entire populated area of the country. The prevalence and menace of the disease have been demonstrated; the people have been interested and instructed; an awakened public sentiment has multiplied appropriations for public health purposes many fold; Federal and state departments of health with en-

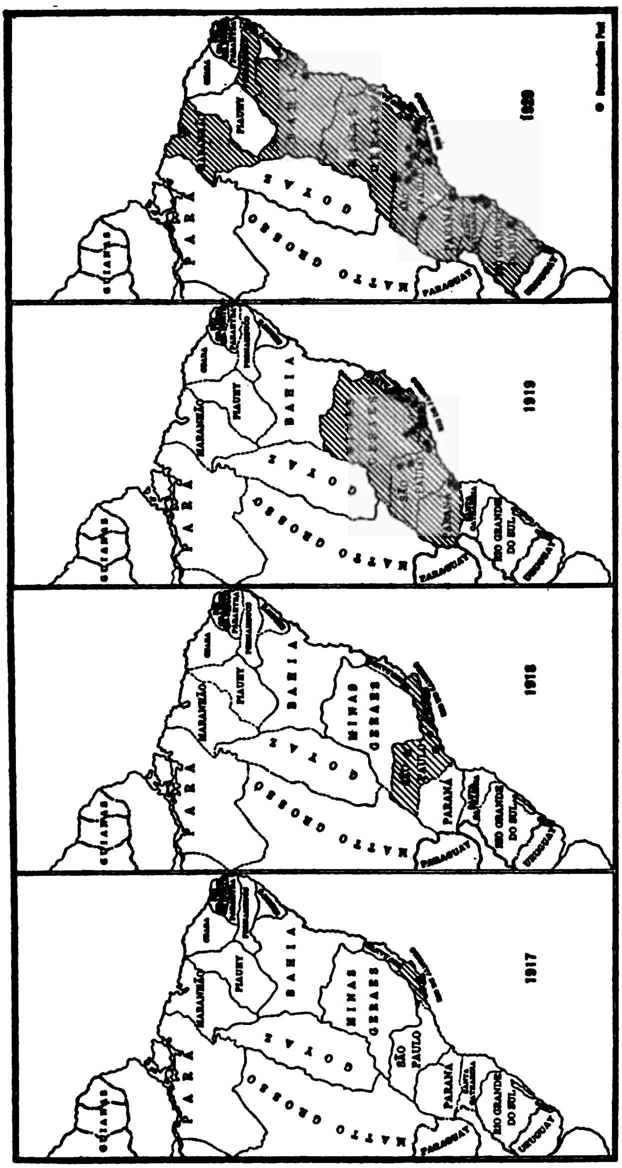

Fig. 19.—Growth of anti-hookworm effort in Brazil. States conducting work and posts maintained, 1917–1920

larged powers and increased resources have united in a national scheme of rural sanitation in which hookworm disease and malaria are given first place. A heartening example of government team-play! In addition to sharing in the scheme of rural sanitation on an equal basis with the states, the Federal service—recently expanded into a national department of health under the energetic leadership of Dr. Carlos Chagas—is organizing for the Federal District special services for venereal diseases and tuberculosis. A part of the plan is to be a training center for visiting nurses in Rio de Janeiro.

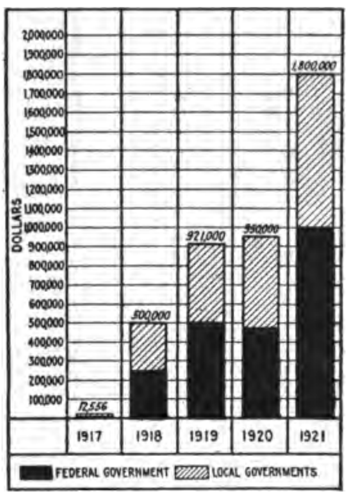

Fig. 20.—Increase in funds appropriated for rural sanitation by Federal and local governments in Brazil, 1917-1921

Here, as in the Southern States, the time has arrived for gradually releasing funds that have been devoted to demonstrations in the control of one disease in order to apply them in ways that may serve the cause to best advantage under present conditions. It is recognized that among the more important immediate needs in the

further development of effective service in Brazil are: the introduction of the trained visiting nurse; county organization as an integral part of the state system; and at least one institution adequately equipped to provide training for the personnel needed to meet the requirements of this almost unprecedented expansion in public health resources and activities.

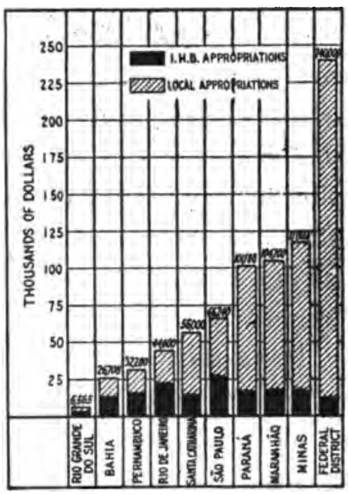

Fig. 21.—Funds available for hookworm work in Brazil, 1920, by states

Progress in Central America

The Central American republics are small and their resources are limited. Measures against hookworm disease were undertaken in these countries in 1914 and 1915 with little expectation of rapid development in general sanitation. Expectations are being exceeded. In **Guatemala** under the new government the public health service has been reorganized and provided with larger resources; by executive decree latrine construction has been made obligatory; and fellowships are being provided for the better training of personnel. In **Salvador** preventive measures

are in progress in twelve of the fourteen departments; Government has reorganized the national health service; is laying the foundation of a diagnostic laboratory service; and has made available for the year about $97,000 for public health purposes. In **Nicaragua** considerable progress is being made in soil sanitation; Government is establishing a national department of health and is asking the Board's counsel in its organization; and a fellowship has been provided as a first step in the training of men for this service. In **Panama** a permanent sanitary staff is being slowly but steadily developed; and Government has more than doubled its annual appropriation for the work.

In **Costa Rica** the first stage of the work has been completed. The country has been systematically covered; Government has steadily increased its support and has created a national department of health with a special division for the control of hookworm disease. According to present plans entire responsibility for the support and administration of the work is to be transferred to national authorities, and the Board's representative is to be withdrawn by the end of July, 1921. A limited number of fellowships are to be provided for the training of Costa Rican physicians for the new Government service.

Fig. 22.—Tuberculosis patients cared for by public health clinic. One feature of county health work. Grenada county, Mississippi

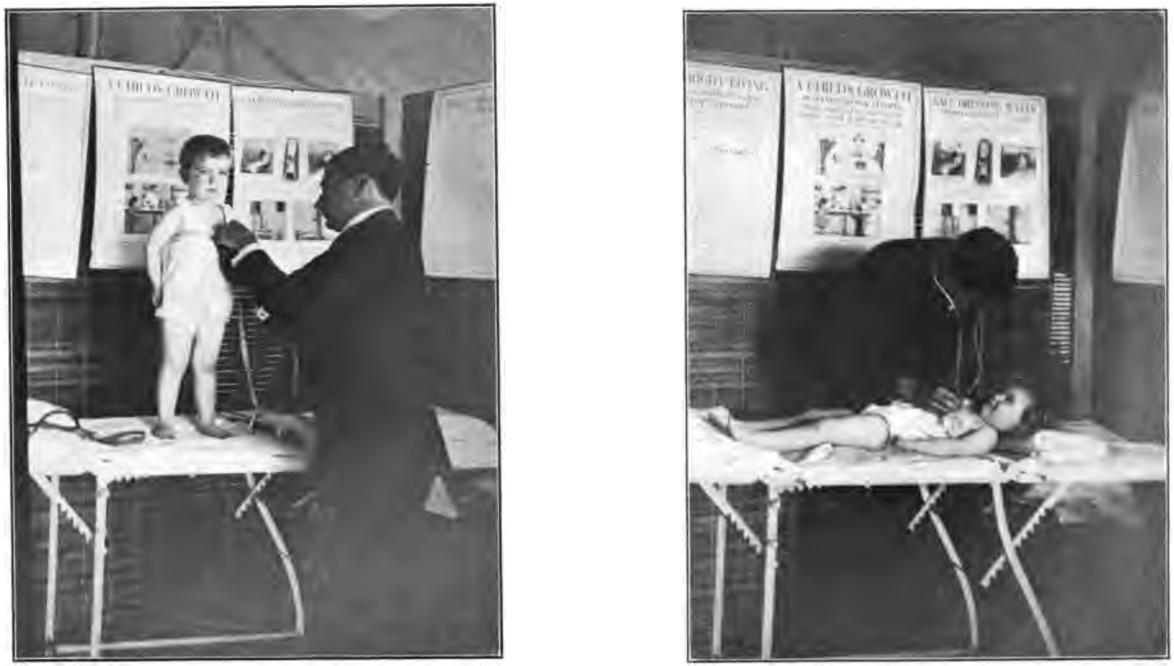

Fig. 23.—Baby clinic, where children from six months to five years were given free medical examination. Another feature of county health work, Grenada county, Mississippi

First Demonstration in Colombia

The first demonstration in measures against hookworm disease in Colombia was opened with official ceremonies in June, 1920. A survey carried out during the previous year had suggested an average infection of about 75 per cent for the entire population. It is estimated that there are in the country approximately 3,250,000 infected persons, more than 300,000 of whom have been rendered non-productive by this one preventable disease. Officials, planters, and the people are keenly interested and have given active support. Government has pushed soil sanitation far in advance of the mobile clinics and within six months has increased its tax-supported sanitary staff from eleven to eighty-five. One hears talk of a ministry of health. In the meantime the Board is providing fellowships in public health for a limited number of promising young Colombian physicians.

Promoting Sanitation in the Far East

Hookworm control as a means to public health is making progress in the Far East. Notable developments in **Australia** are reported in a separate section. **India,** with its population of more than 300,000,000, suffers the handicap of an extremely heavy infection and for years has served as an endemic focus from which, through

the emigration of labor, the disease has been carried to many lands. It is among the Tamil coolies imported from South India that the heavier infection is found today in Ceylon, the Federated Malay States, Fiji, Natal, British Guiana, and some of the West Indies. The first systematic attack on the disease at this important source was made by Lieut. Col. Clayton Lane, of the Indian Medical Service, in 1916 on the tea estates of Assam. In response to official request the Board sent a representative during the year to direct operations in Madras presidency, and it has under consideration a similar proposal from Bengal. The island of **Mauritius** has been surveyed preparatory to an active campaign. In **Fiji** Government is undertaking advance soil sanitation in preparation for a revival of the field clinics which were suspended during the war. In **Ceylon** the clinics, having completed for the time being their work on the rubber and tea estates, have been transferred to the low-country villages for a series of demonstrations among the native Singhalese. By joint action of Government and planters, sanitation on the estates is being continued but on most of them has not yet reached a satisfactory standard. In the **Seychelles** Government has undertaken a thoroughgoing demonstration in hookworm control. The islands have been cov-

ered by a systematic campaign of treatment and education, sanitation is being continued under official inspectors, and as shown by re-survey carried out during the year a marked reduction in the infection rate has been accomplished. In **Siam**, with strong Government backing and energetic Red Cross participation, the field clinics are treating more than 1,000 persons per week. Soil sanitation is making perceptible progress, though under extreme difficulties, and an active educational propaganda is driving home over a wide region the lessons the clinics are teaching. Government has recently expressed a desire to have the work, which hitherto has been confined to northern Siam, made national in scope. This move makes acute the need of a modern medical school in Bangkok for the adequate training of Siamese physicians.

Creating a Ministry of Health in Australia

Australia has shown its usual enterprise in taking advantage of the presence of a relatively light hookworm infection in a limited region for the promotion of a Commonwealth scheme of public health. The movement began in 1917 with an infection survey of Papua. A survey and demonstration in Queensland the following year led to an undertaking on a national scale in which the Federal quarantine service and the

states united. For two years under this joint arrangement the country has had a demonstration in effective team-play. Officials, physicians, and the people have given support; measures for the control of hookworm disease are being expanded into a more comprehensive plan of rural sanitation; and the new service is being extended to the states, to Papua, and to the territory formerly known as German New Guinea. And now comes report of a step of far-reaching importance. To meet its share of the increasing responsibility the Commonwealth government has created a ministry of health. Under the energetic leadership of Dr. J. H. L. Cumpston, formerly head of the Federal quarantine service, no time is being lost in its organization. In response to request the Board has undertaken to lend to the new ministry during the early stages of its development the services of Dr. Sawyer—its present representative in the country,—of an industrial hygienist, and of a sanitary engineer; to assist in the maturing of plans for a public health laboratory service; and to provide a limited number of fellowships for the training of Australian personnel.

Field Studies

The Board has not entered the field of research as such; it is engaged primarily in promoting

Fig. 24.—Czechoslovakian commission just before sailing to make a tour of medical centers in England and the United States. Left to right, standing: Dr. Vacek, Dr. Halik, Dr. Bazika, Dr. Hovorka (secretary to Minister of Public Health), Dr. Petrik. Left to right, sitting: Mr. Kolinsky, Col. Russell, Dr. Prochazka (Minister of Public Health), Prof. Gunn. (Col. Russell and Prof. Gunn were not members of the commission)

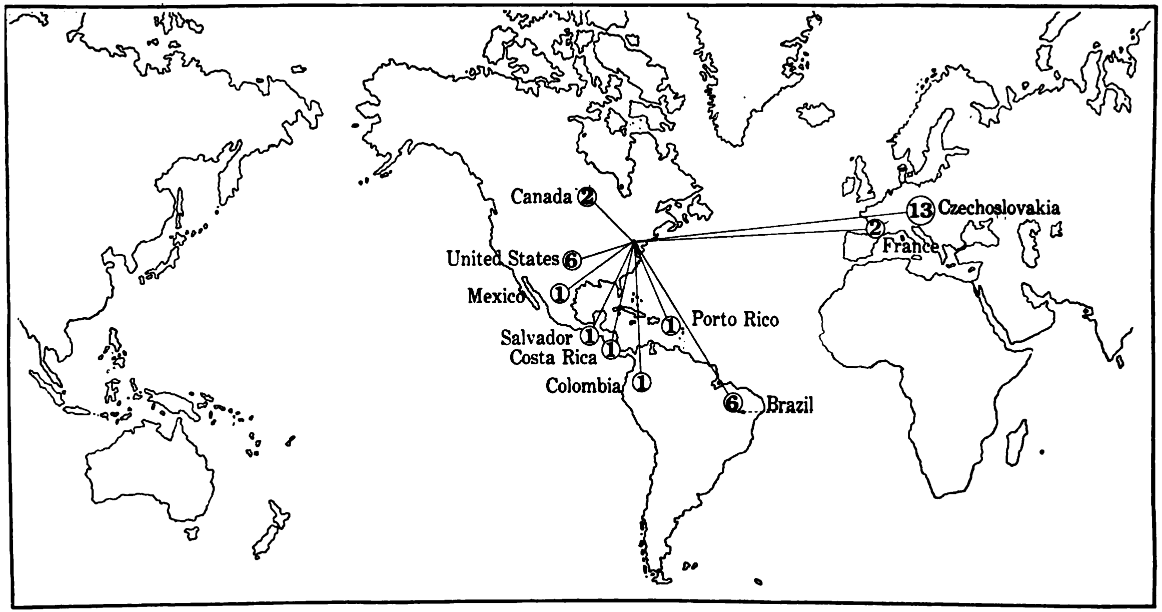

Fig. 25.—The International Health Board has provided thirty-four fellowships for advanced training in public health. The map indicates the countries from which the students have come

the more effective use of the knowledge which we have in the control of disease. It does aid in developing schools of hygiene which are expected to add to knowledge, and it contributes directly to research when in need of an answer to questions arising from its practical field work. During the year field studies have been conducted concerning hookworm infection; treatment of hookworm disease; technique of stool examination; fish as a factor in mosquito control; and effect on malaria incidence of screening, killing mosquitoes in dwellings, and impounding water in bayous. Members of the field staff have assisted Dr. Noguchi of the Rockefeller Institute in the further testing of his yellow fever vaccine and serum. Results of the studies in the treatment of hookworm disease carried out by Dr. Darling and Dr. Smillie in Brazil are being put to practical test in a number of field clinics in that country, with indications of a very considerable gain in speed and economy of operation.

Public Health Laboratory Service

The laboratory and reliable vital statistics are the necessary basis of intelligent public health administration. In response to repeated requests for counsel the Board has made provision, in the appointment of Colonel F. F. Russell

of the Army Medical Service to membership on its staff, for giving aid to governments in organizing or further developing their public health laboratory service. He has given such assistance during the year to Alabama, Mississippi, Kansas, and Czechoslovakia.

Creating a Health Service in Czechoslovakia

Under the Empire the administration of public health for the areas now constituting Czechoslovakia was centered in Vienna and Budapest. The present Government is confronted with the task of creating a new service and training a staff to administer it. By invitation two representatives of the Board visited Prague in February for conference with Government authorities and a preliminary study of conditions. Proposals matured at that time and approved by the Board at its meeting in May are now in operation. The Board has a representative at Prague placing American experience at the service of the ministry and interpreting Czech conditions and experience to the home office; as guests of the Board a group of officials representing the ministry have visited England and the United States to study public health administration; thirteen fellowships in public health have been provided for young Czech physicians in training

for the service being developed at home; and during the autumn the Board's laboratory specialist visited the country and assisted in maturing plans for a national public health laboratory service. The plans provide for a laboratory at Prague, with branch laboratories, as the service requires, at suitable points throughout the country. The scheme will center in an institute of public health with seven divisions: providing for anti-rabic vaccinations; production of smallpox vaccine; production of sera; food inspection; drug inspection; diagnostic laboratory; and courses for the training of public health workers. It is to be under the ministry of health and on the side of instruction is to be intimately related to the University Medical School. Government has appropriated for public health purposes for the year 1921, 81,891,717 crowns.

Institutes of Hygiene and Training in Public Health

The key to permanent progress is in the development of the science of hygiene and the training of men for practical public health administration. There is opportunity at the present time for important work by a limited number of institutions with adequate resources that shall undertake to cover broadly the field

of hygiene and public health, and to combine with the work of instruction and of practical training the cultivation of the fundamental sciences. In addition to these there will be more abundant facilities in the form of short intensive courses for the continued improvement of the workers in the service. The Johns Hopkins School of Hygiene and Public Health enrolled during the year one hundred students, of whom twenty-nine took the short course. Proposals have been submitted for the development of schools of public health at Prague and at São Paulo, Brazil. The Board contributed toward the maintenance of a health officers' institute or short course in Georgia; and plans are being matured for a similar institute for visiting nurses in the state of New York. The Board provided during the year thirty-four fellowships in public health for selected physicians from ten countries: Mexico, Salvador, Costa Rica, Porto Rico, Colombia, Brazil, France, Czechoslovakia, Canada, and the United States.

Publications

The following is a complete list of the reports and publications issued by the International Health Board during the year 1920:

PRINTED REPORTS (*for general distribution*)

Annual Report for the Year 1919.

Hookworm and Malaria Research in Malaya, Java, and the Fiji Islands (Report of Uncinariasis Commission to the Orient, 1915-1917). By S. T. Darling, M.D., M. A. Barber, Ph.D., H. P. Hacker, M.D.

LITHOGRAPHED REPORTS (*for limited distribution*)

Annual Reports for 1919 on Work for the Relief and Control of Hookworm Disease in the following countries:

West Indies

British Guiana	Dr. F. W. Dershimer
Jamaica	Dr. P. B. Gardner
St. Lucia	Dr. Stanley Branch
Trinidad	Dr. G. C. Payne

Central America

Costa Rica	Dr. Louis Schapiro
Guatemala	Dr. W. T. Burres
Nicaragua	Dr. D. M. Molloy
Panama	Dr. F. A. Miller
Salvador	Dr. C. A. Bailey

South America

Brazil	Dr. L. W. Hackett

The East

Ceylon	Dr. W. P. Norris
Queensland	Dr. W. A. Sawyer
Seychelles	Dr. J. F. Kendrick
Siam	Dr. M. E. Barnes

Report on Hookworm Infection Survey and Malaria Survey of Porto Rico from December 26, 1919, to January 28, 1920—Dr. J. B. Grant.

Report on Use of Top Minnow (*Gambusia affinis*) as an Agent in Mosquito Control—Dr. H. H. Howard.

Articles and Reprints

The following is a list of other contributions to medical and public health literature which were made during the year, most of them in the form of

articles published in medical journals that are widely circulated among persons interested in medical and public health topics:

DR. C. C. BASS

Attempt to explain the greater pathogenicity of Plasmodium falciparum as compared with other species. *Journal of Tropical Medicine and Hygiene*, Oct. 1, 1920, v. 23, p. 237–238.

Campaign against malaria: malaria, how to get rid of it. Mississippi State Board of Health. *Health Bulletin*, Oct.–Dec., 1920, v. 8, p. 1–2. Same reprinted.

Responsibility of physicians who treat malaria cases. *Southern Medical Journal*, Oct., 1920, v. 13, p. 693–695.

Studies on malaria control:

No. 10. Cure of infected persons as a factor in malaria control. *American Journal of Public Health*, Mar., 1920, v. 10, p. 216–221. Same reprinted.

No. 11. Control of malaria by quinine sterilization of the human host. *Southern Medical Journal*, Apr., 1920, v. 13, p. 250–256. Same reprinted.

DR. M. E. CONNOR

Yellow fever control in Ecuador; preliminary report. *Journal of the American Medical Association*, Mar. 6, 1920, v. 74, p. 650–651. Same reprinted. Spanish trans. in *Journal of the American Medical Association* (Spanish edition), Apr. 1, 1920, v. 3, p. 456–458. Same reprinted.

Yellow fever in Ecuador; final report. *Journal of the American Medical Association*, Oct. 30, 1920, v. 75, p. 1184–1187. Same reprinted.

DR. S. T. DARLING

Experimental inoculation of malaria by means of Anopheles ludlowi. *Journal of Experimental Medicine*, Sept. 1, 1920, v. 32, p. 313–329. Same reprinted.

Observations on the geographical and ethnological distribution of hookworms. *Parasitology*, Sept., 1920, v. 12, p. 217–233. Same reprinted.

Suggestions for the mass treatment of hookworm infection. *Lancet*, July 10, 1920, v. 2, p. 69–72. Same reprinted.

DR. S. T. DARLING & DR. W. G. SMILLIE

Teaching of vital statistics to medical students in Brazil. *Journal of the American Medical Association*, July 31, 1920, v. 75, p. 337–339. Same reprinted.

DR. J. A. FERRELL

Results of recent efforts to control malaria. *Southern Medical Journal*, Apr., 1920, v. 13, p. 256–260. Same reprinted.

Rôle of the latrine in the control of hookworm disease. *American Journal of Public Health*, Feb., 1920, v. 10, p. 138–140. Same reprinted.

Compensation of health officers. *American Journal of Public Health*, July, 1920, v. 10, p. 569–575. Same reprinted.

DR. W. C. GORGAS, DR. H. R. CARTER, & DR. T. C. LYSTER

Yellow fever; its distribution and control in 1920. *Southern Medical Journal*, Dec., 1920, v. 13, p. 873–880. Same reprinted.

DR. JUAN GUITERAS

Observations on yellow fever in Martinique. *Sanidad y Beneficencia*, Havana, Apr.–June, 1920, v. 23, p. 232–236.

DR. L. W. HACKETT

O problema da uncinariose (The hookworm problem). *Brazil-Medico*, Rio de Janeiro, July 31, 1920, v. 34, p. 497.

DR. H. H. HOWARD

Malaria control in communities by anti-mosquito measures. Mississippi State Board of Health. *Health Bulletin*, Oct.–Dec., 1920, v. 8, p. 2–5. Same reprinted.

Malaria control in rural communities by anti-mosquito measures. *Southern Medical Journal*, Apr., 1920, v. 13, p. 260–266. Same reprinted.

E. C. MEYER

Community medicine and public health. *American Journal of Public Health*, June, 1920, v. 10, p. 489–497. Same reprinted.

Discussion of Dr. Emerson's paper, "A standard budget." *American Journal of Public Health*, Apr., 1920, v. 10, p. 353–354.

Methods for the defense of public health appropriations. *American Journal of Public Health*, Mar., 1920, v. 10, p. 201–209. Same reprinted.

DR. G. P. PAUL

The planters and hookworm disease. *Planters' Chronicle*, Coimbatore, Madras, India, Oct. 2, 1920, v. 15, p. 672–674.

DR. W. G. SMILLIE

Beta-naphthol poisoning in the treatment of hookworm disease. *Journal of the American Medical Association*, May 29, 1920, v. 74, p. 1503–1506. Same reprinted. Spanish trans. in *Journal of the American Medical Association* (Spanish edition), June 15, 1920, v. 3, p. 798–802.

Plague-like organisms in the wild rats of São Paulo, Brazil. *Journal of Infectious Diseases*, Oct., 1920, v. 27, p. 378–384. Same reprinted.

Prevalence of Leptospira ictero-hemorragiae in the wild rats of São Paulo, Brazil. *Bulletin, Société de Pathologie Exotique*, Paris. July 7, 1920, v. 13, p. 561–568. Same reprinted.

Dr. G. K. Strode

Medical inspection of schools in Pennsylvania. *Modern Medicine*, Nov., 1920, v. 2, p. 758–761.

Dr. H. A. Taylor

Malaria control through the application of anti-mosquito measures and some of the results obtained in southeast Arkansas. *Southern Medical Journal*, May, 1920, v. 13, p. 339–344. Same reprinted.

G. E. Vincent

America's world war against disease. *New York Times Current History*, Oct., 1920, p. 131–136.

Ideals and their function in medical education. *Journal of the American Medical Association*, Apr. 17, 1920, v. 74, p. 1065–1068. Same reprinted. Spanish trans. in *Journal of the American Medical Association* (Spanish edition), June 15, 1920, v. 3, p. 795–798. Same reprinted.

The missionary doctor in China; past achievements and future outlook. *China Medical Journal*, Shanghai, May, 1920, v. 34, p. 325–328. Same reprinted.

The Rockefeller Foundation's work in Pan-America. *Bulletin, Pan-American Union*, Washington, Oct., 1920, v. 51, p. 389–403.

Dr. B. E. Washburn

Co-operative county health work in North Carolina. *Southern Medical Journal*, Oct., 1920, v. 13, p. 710–712.

Dr. B. L. Wyatt

Work of the Commission for the Prevention of Tuberculosis in France in the department of Eure-et-Loir. *American Review of Tuberculosis*, July, 1920, v. 4, p. 347–369. Same reprinted.

Dr. F. C. Yen

Control of hookworm disease at the Pinghsiang colliery, Ngan Yuen, Kiangsi. *National Medical Journal of China*, Shanghai, June, 1920, v. 6, p. 71–92.

APPENDIX

ACKNOWLEDGMENT

Extensive use has been made of the following special articles and reports in compiling the appendix, particularly the sections dealing with hookworm disease and county health work:

"Studies on Hookworm Infection in Brazil," by S. T. Darling and W. G. Smillie; published as monographs of the Rockefeller Institute for Medical Research, New York City, 1921.

"Studies in Relation to the Technique of Field Campaigns," by W. G. Smillie.

"Co-operative County Health Work in North Carolina," by B. E. Washburn; published as health bulletin of North Carolina State Board of Health, Raleigh, N. C., January, 1920.

In certain instances the authors' own words have been used. The Board is indebted to these as well as to many other members of the staff for contributions in the form of reports and articles which have made possible the following statement of findings and results.

APPENDIX

I

EXTENT AND SEVERITY OF HOOKWORM DISEASE[1]

During 1920 hookworm infection surveys were conducted in sixteen areas.[2] In these areas the incidence as indicated by microscopic examination of feces ranged from the complete absence of infection recorded in four Australian states to the almost universal infection recorded in the states of Bahia, Pernambuco, and Maranhão, Brazil. In areas where the rate of infection was high the disease was found to be prevalent even among those who had the means to cure and who protect themselves against it. Thus, in the state of Santa Catharina, in Brazil, 78 per cent infection was recorded among those who could read, 57 per cent among those who claimed to use latrines, and 46 per cent among a group of teachers, doctors, druggists, lawyers, and fazenda or plantation owners.

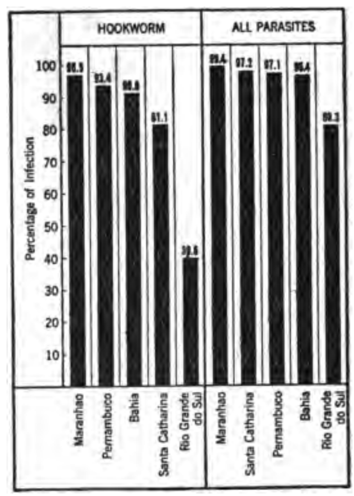

Fig. 26.—Incidence of hookworm and other parasitic infection in five Brazilian states surveyed during 1920

Distribution of Hookworm Disease in Brazil. Surveys have now been made of all the larger states of the Brazilian littoral except Pará. The general results are indicated on the map, Fig. 27. The southern boundary of Bahia may be taken as the dividing line between an area of severe infection to the north and an area to the south where the infection, although probably still high in rural regions, is on the

[1] Based on 1920 infection surveys.

[2] The states of Bahia, Pernambuco, Maranhão, Rio Grande do Sul, and Santa Catharina in Brazil; the republic of Colombia; the islands of Porto Rico, Santo Domingo, and Mauritius; the presidency of Madras, India; and the states of Queensland, South Australia, Victoria, Northern Territory, New South Wales, and Tasmania in Australia.

average less intense. This area of less intense infection extends to the southern boundary of São Paulo. Along the coast the incidence remains about 80 per cent to the extreme southern limit of Brazil, although in the southernmost state—Rio Grande do Sul—this condition is confined to a very narrow strip indeed. A little further inland the incidence drops to 70 per cent, and beyond falls away rather abruptly to nothing.

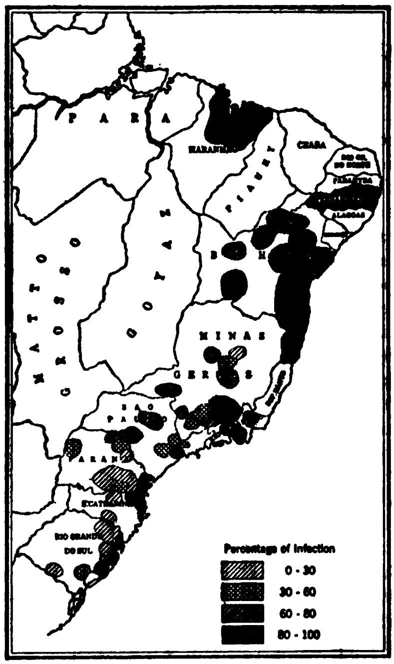

Fig. 27.—Distribution of hookworm infection in Brazil, as indicated by infection surveys. Note extreme high incidence along the coast

Infection along the littoral seems to be invariably more severe than further inland. This condition is probably due in the different regions to different combinations of causes, into which enter climate, concentration of population, and prevailing occupations of the rural inhabitants. In northern São Paulo and southern Minas the high incidence of infection seems to be due mainly to intensive agriculture; in Rio and Santa Catharina to particularly favorable conditions of soil, temperature, and moisture. In the three northern states surveyed the difference is slight but still apparent (Fig. 27).

There remain along the coast six states of relatively small areas which have not yet been surveyed. The indications are that two of these—Piauhy and Ceará, which lie between Maranhão and Bahia—will not show the same high incidence of infection as the latter states. Piauhy and Ceará suffer periodically from long-continued droughts—sometimes a year passes without rain; and this situation in itself would tend to control hookworm infection. Alagoas and Sergipe will probably show the same infection as the bordering states of Pernambuco and Bahia; Parahyba and Rio Grande do Norte may be expected to show a transition from the universal infection of Pernambuco to the less serious situation supposed to exist in Ceará.

In the great interior states of Brazil the population is so sparse that hookworm disease becomes one of the less important problems.

Infection Rate in Colombia. In the infection survey of Colombia, investigation was limited to the department of Cundinamarca. This department includes within its boundaries all the climatic zones into which the country is divided and is believed to be fairly representative of the country at large.

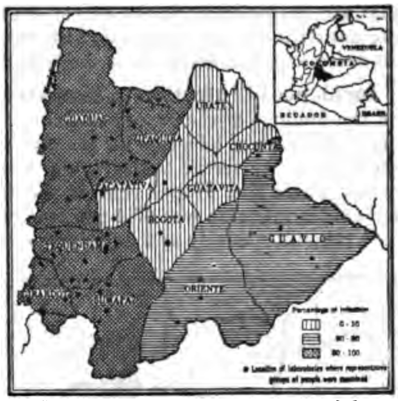

Fig. 28.—Infection survey map of Cundinamarca, Colombia. (Insert shows location of the department in the republic)

Examination of 8,465 representative persons from forty-five different districts and all of the zones showed 6,613, or 78.1 per cent, to be harboring hookworms. The incidence was found to vary inversely with the altitude, decreasing rapidly as the cold zone was approached. The highest rate of infection (88.1 per cent) was found in the provinces of Guaduas and Tequendama; the lowest (9.6 per cent) in Bogotá and Guatavita (Fig. 28).

The survey findings in Cundinamarca showed that the people who lived in districts having an altitude of less than 6,600 feet had an average infection rate of 84.4 per cent. Among those who lived in higher altitudes the average percentage of infection was 20.4 (Fig. 29). By applying these figures to the country as a whole, it was calculated that in a population of 5,072,613 there were as many as 3,320,602 infected persons. Since 10 per cent is a reasonable estimate of the number of hookworm cases

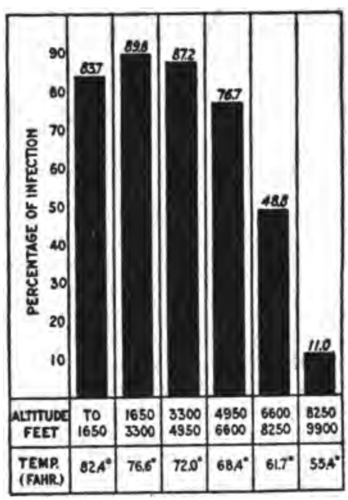

Fig. 29.—Hookworm infection in relation to altitude. Colombia. In zones of less than 6,600 feet elevation, infection was practically universal

that are unable to work, the survey may be taken as indicating that the nation is supporting more than 300,000 persons who have been rendered non-productive by a single preventable disease.

Incidence of Infection in Santo Domingo. An estimate based on the findings of the survey of Santo Domingo places the approximate incidence of infection for the country at about 50 per cent. In the Cibao, the fertile valley lying north of the central mountain range, where live 57 per cent of the total population, the rate of hookworm infection was 67.4 per cent (Fig. 30). This region is not only the most densely and uniformly settled part of the country, but

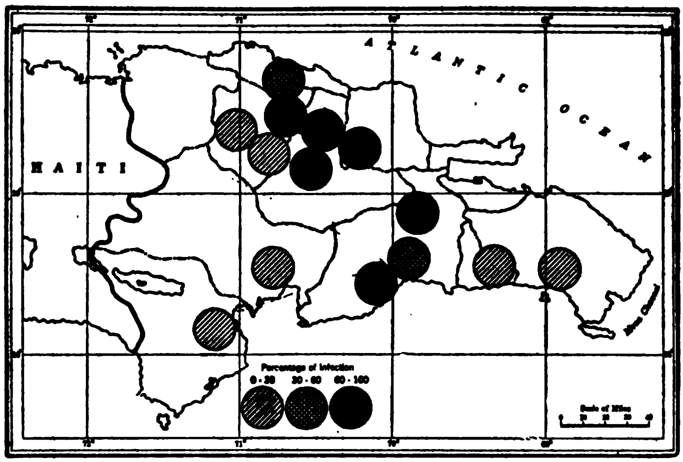

Fig. 30.—Distribution of hookworm disease in Santo Domingo

it presents, with its soil of rich loam and its constantly recurring rainfall, conditions almost ideal for the propagation of hookworm larvae. In the plains south of the mountain range, where dwell an additional 28 per cent of the population—living chiefly along the seacoast—the infection revealed was 43 per cent. Here was found the greatest variation in the incidence of infection; it was heaviest in the vicinity of the capital and lowest in the more sparsely settled sections lying along the southeastern coast. The arid western area, comprising the provinces of Monte Christin Azua and Barahona, with a very sparse population which approximates only 15 per cent of the total for the country, revealed a hookworm incidence of 11.4 per cent.

The clinical results of the infection are not severe, probably because the population is largely of negro blood and the infection is in the main of recent origin. Tests made during the course of the survey showed that the hemoglobin of persons with hookworm disease was not greatly reduced. In 283 infected persons the average hemoglo-

bin was found to be 74.4 per cent, as compared with an average hemoglobin of 79.3 per cent in 221 uninfected persons. Nevertheless, in spite of the fact that the disease has thus far caused little clinical anemia, there is much to indicate that its presence is a serious hygienic and economic problem and likely to become an ever more pressing one as time goes on. The need of controlling it, therefore, stands among the more important specific sanitary problems to be met by the island government.

Hookworm Infection in Mauritius. In Mauritius not less than two of every three among the 2,867 persons examined were found to be harboring the hookworm parasite. The persons examined included all ages, all races, and both sexes, and were chosen indiscriminately over wide areas. The infection rate ranged from 29.4 per cent among residents of the Port Louis district to 100 per cent among those of Moka (Fig. 31). From the survey records it may be conservatively estimated that 226,000 persons in the colony are infected.

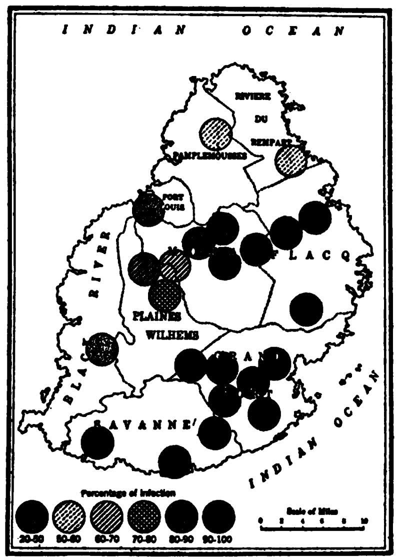

Fig. 31.—Hookworm infection survey map of Mauritius

The effects of the disease fall most heavily on the East Indian estate laborers, many of whom are extremely weak, anemic, and edematous, and suffer from disturbances of the heart. Persons presenting these symptoms were seen in all parts of the island, but more frequently in the districts with the higher percentages of infection. Districts with much rainfall had consistently higher and more severe types of infection than those with little rainfall, the incidence of infection in wet and dry districts being, respectively, 74.6 and 44.7 per cent (Fig. 34).

Hookworm Survey of Madras Presidency, India. Demonstrations or surveys were conducted during 1920 in the Cannanore jail in Madras presidency, India, on various tea estates, and later in the city of Madras. On the tea estates a total of 2,300 laborers were examined, and the infection rates were found to vary from 83 per

cent among laborers from dry districts to 100 per cent among those from wet districts. Among 964 inmates of the Cannanore jail, a hookworm incidence of 89.7 per cent was found. Prisoners drawn from all but three of the twenty-four districts of the Presidency were included in the number examined. There were very few instances of severe or even moderately severe hookworm disease among the prisoners; among the estate laborers, on the other hand, the proportion of severe cases, as determined by clinical observations as well as by hemoglobin tests, was very large.

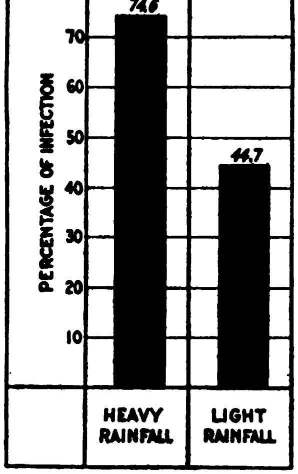

Fig. 32.—Effect of rainfall on hookworm propagation. Comparative incidence of the disease in districts with heavy and with light rainfall. Mauritius

The city of Madras was chosen for investigative work in an industrial center. Among urban residents employed in the cotton and silk mills of the city, two of every three persons examined were found to be infected. The rate of 55.7 per cent found among school children, who almost without exception go barefoot, was in sharp contrast with the rate of 15.8 per cent which obtained among teachers, almost all of whom wear shoes.

Hookworm Infection Not Widespread in Australia. The results of the work in Australia up to December 31, 1920, lead to the conclusion that hookworm infection is confined principally to irregular pockets and is not very widespread. The principal factor determining the shape and position of the pockets seems to be rainfall. This has greater influence upon the extent and severity of infection than have variations in methods of night soil disposal: in some communities of low rainfall hookworm disease has gained no foothold in spite of the grossest carelessness in the disposal of feces.

Relationship between Rainfall and Infection. Surveys conducted during the year in South Australia and Victoria, where rainfall is low and occurs mostly in winter, indicate that hookworm disease is absent from the mines as well as from the surface. Similarly, a survey of the important group of deep mines at Broken Hill, in New South Wales, and another survey begun on a small scale in and around the city of Darwin, in Northern Territory, have disclosed no hookworm infection.

In Papua the infection rate is high, 58.8 per cent of the 18,088 persons examined to date having been found infected. Even in this

Fig. 33.—Worms recovered from nine-year-old boy as result of one treatment with oil of chenopodium. Eighty-nine hookworms and eighty-one Ascaris. This demonstration induced many to apply for treatment. Brazil

Fig. 34.—Laborers at estate camp in island of Mauritius. One hundred per cent hookworm infection

tropical country, however, there is an area along the southern coast in which rainfall is low and the incidence of hookworm disease is much reduced. Of the areas examined on the continent of Australia, only the state of Queensland has thus far shown a serious hookworm problem; even here, however, the infection is confined to a narrow strip of coastal area. Inland from the coastal ranges the rainfall is low and hookworm disease is rare or absent (Fig. 35.)

Racial Incidence of Infection. Infection by race presents a curious anomaly in Australia. In the few places where the aborigines still live together, they have a much higher infection rate than the white people of the same district. It is only occasionally that a community is found where more than 30 per cent of the whites are infected. Aborigines living under the same conditions are all likely to be infected. In Papua, also, the high infection is almost entirely limited to natives. There are, however, only a few whites living in the latter territory.

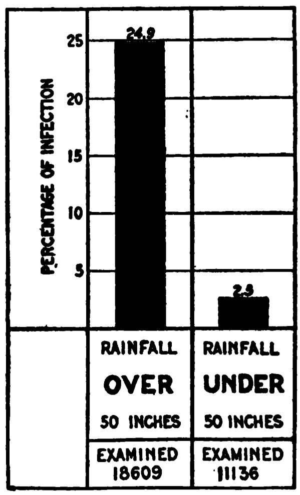

Fig. 35.—Relation of rainfall to hookworm incidence. North Queensland, Australia

SEVERITY OF HOOKWORM DISEASE

Usually, the higher the percentage of persons infected in a given locality, the larger is the average number of worms harbored by infected persons, the more severe are the symptoms, and the more difficult is it to bring the disease under control. Rates in the preceding paragraphs relating to the incidence (but not the severity) of the infection are based entirely on the results of search with the microscope for eggs in the feces. The work of Darling and Smillie has shown, however, that the microscope offers no trustworthy index of the *number* of worms harbored by infected individuals. This information may be accurately ascertained only by giving the persons a vermifuge and counting the worms expelled after the drug has acted. Studies which seek to establish through microscopic examination the relationship of race, sex, age, occupation, and similar factors to the *incidence* of hookworm infection lose a large part of their value when considered in the light of information revealed by the worm-count method.

Value of Worm-Count Surveys. The fact that the microscope cannot be expected to reveal differences in the amount of the infec-

5

tion was demonstrated, for instance, in the state of São Paulo, where worm counts showed that male coffee pickers had 350 worms on the average while their wives had only fifty; yet the microscope could do no more than call positive both the husbands and the wives.

Worm counts are scarcely practicable when the incidence or severity of the disease is to be studied over a wide area and within a limited period of time. Nevertheless, it is sometimes feasible to make them as an incidental feature of the work within restricted areas, and this was done in the course of the infection surveys conducted during 1920 in the states of Pernambuco and Santa Catharina, Brazil. In Pernambuco from 500 to 800 worms were repeatedly recovered from the feces passed by agricultural laborers during the first few hours after treatment, and in Santa Catharina the worms obtained after treatment with thirty-five to forty drops of chenopodium ranged from 1 to 1,156. One child of five years expelled 412 hookworms. In the latter state, moreover, children from nine to twelve frequently expelled from 100 to 150 Ascaris (Fig. 32).

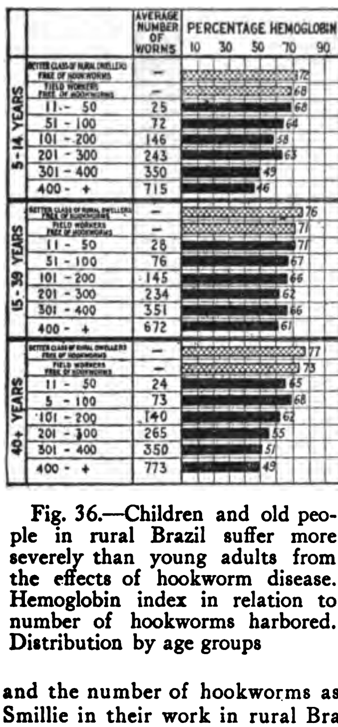

Fig. 36.—Children and old people in rural Brazil suffer more severely than young adults from the effects of hookworm disease. Hemoglobin index in relation to number of hookworms harbored. Distribution by age groups

Correlation between Number of Hookworms and Hemoglobin Index. The hemoglobin index is a very good means for determining, in the case of individuals as well as of groups, the degree of injury that hookworms are producing. Fig. 36 illustrates the relationship between the hemoglobin index and the number of hookworms as ascertained by Drs. Darling and Smillie in their work in rural Brazil. Seventy-five worms are seen to produce in all groups a definite lowering of the hemoglobin amounting to about four points. As the worms increase in number beyond this figure, the hemoglobin of children and of persons more than forty years of age declines rapidly and continuously until the index of cases with upward of 400 hookworms is more than twenty points below normal.

Persons between fifteen and thirty-nine offer such strong resistance to the disease that even 675 to 700 hookworms cause a decline

in hemoglobin of only ten points. In interpreting these facts, it should be borne in mind, however, that hookworm infection is slowly acquired, that the blood-forming elements of the bone marrow are active, and that the body defenses struggle against the hookworms to retain the normal hemoglobin. In older individuals and in children the body defenses have little endurance, and if hookworm infection is heavy, the battle is a losing one.

Hookworm the Chief Anemia-Producing Factor in Santa Catharina. In a study of 9,482 persons in Santa Catharina hookworm disease was easily incriminated as the chief cause of anemia. As a single factor in the production of anemia it appeared on the average more potent than malaria, although it produced its severest anemia only when in conjunction with malaria. Regionally and occupationally the infection was correlated with the intensity of anemia. It was evident that of all the groups examined the inhabitants of the coastal plain (90 to 95 per cent infected) suffered most severely from anemia, and chief among them the field workers (94 to 98 per cent infected), who represent one fourth of the population and are the chief producers of wealth. Second in both extent and gravity of anemia were those less than nineteen years of age (90 to 93 per cent infected), and third the housewives (80 to 85 per cent infected).

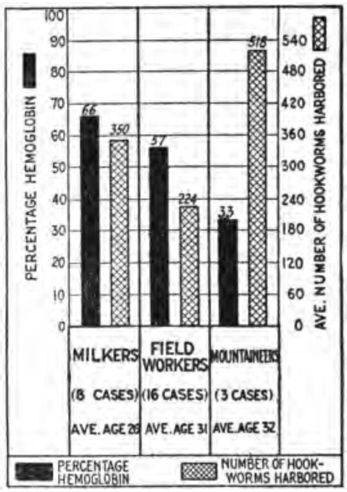

Fig. 37.—Malnutrition and hookworm disease as factors in producing anemia. Comparative study of well nourished and poorly nourished occupational groups. Milkers well fed; field workers moderately well fed; mountaineers poorly nourished. Brazil

Hookworm Disease and Malnutrition in Relation to Anemia. In the state of São Paulo, Brazil, however, studies of hookworm disease and the food factor in their relation to the production of anemia suggested that malnutrition, especially when it approaches the point of starvation, is more potent even than heavy hookworm infection in reducing the hemoglobin. One of the São Paulo studies was based on worm counts and hemoglobin tests of eight milkers who engaged in field work part of the time, of sixteen laborers who gave all their time to work in the fields, and of three mountaineers. All of these men were heavily infected. The milkers drank

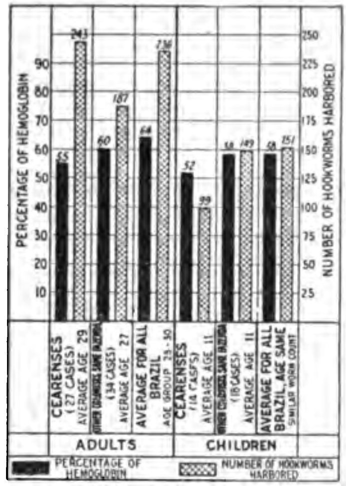

Fig. 38.—Malnutrition and hookworm disease as factors in production of anemia. Resistance to anemia among hookworm infected refugees from famine-stricken district of Ceará compared with that among hookworm infected colonists who had been living on Sao Paulo plantation for several years

plenty of milk and had other good food; the field workers had good food but no milk; the mountaineers were poor and underfed. Fig. 37 compares the hemoglobin average of the three groups. The milkers were relatively strong and active; the mountaineers were weak and listless.

In another study, forty-one refugees who had migrated to São Paulo from the famine-stricken state of Ceará were compared with fifty-two laborers who were native to the state of São Paulo. Both groups at the time they were studied were eating similar food, living under similar conditions, and performing similar tasks in the fields. Both were infected with hookworms. The São Paulo laborers, who were accustomed to a comparatively full diet, had, as Fig. 38 indicates, a much higher hemoglobin index than the refugees from Ceará, who had suffered from malnutrition. The difference was especially noticeable in the case of children. Those from Ceará harbored only 99 worms, as compared with the average of 149 harbored by those who were native to São Paulo, yet the hemoglobin index of the former group was six points lower than that of the latter.

II

FIELD STUDIES OF HOOKWORM DISEASE

Drs. Darling and Smillie have conducted in Brazil a number of investigations in which they have sought to throw light upon the varying incidence and severity of hookworm disease in different groups of the population, and the factors which determine this variation. Their studies have been based on the careful counting of worms expelled by infected persons.[1] They have carried out their experiments in their capacities of Director and Associate Director of the Laboratory of Hygiene at the university of São Paulo, Brazil, and have been assisted in the work by the staff engaged in combating hookworm disease in Brazil.

Direct Contact with Humid Earth Chief Factor in Infection. The studies bearing on the relationship between contact with humid earth and the incidence of infection with hookworm disease demonstrated that under Brazilian conditions hookworm is an occupational disease—a disease of those who work in the soil. The number of worms harbored was found to vary directly with the amount of time the individual spent in bare feet in the fields.

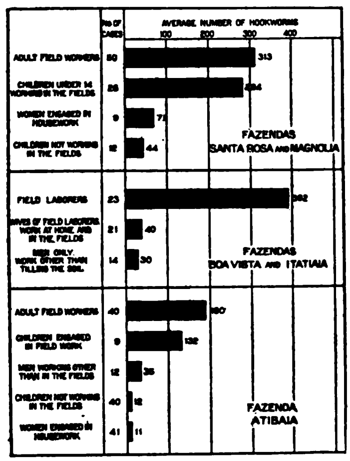

Fig. 39.—Relative intensity of hookworm infection among agricultural laborers and persons engaged in other occupations. 299 cases. Brazil

Fig. 39 shows that on fazendas in several different states, adults and children who worked barefoot in the field were heavily infected, while those who were engaged about the house harbored but few worms. Almost without exception the more intimate and direct was the contact of these people with the humid earth in which the larvae breed, the more severe was the infection they exhibited.

Contrary to expectation, the average infection of people grouped in villages with little or no sanitation—shopkeepers, barbers, and non-agricultural workers generally—proved to be not so heavy as that of persons living in scattered farmhouses. Even though the

[1] For full discussion of the methods employed, see pages 72 and 73.

soil in and about the villages teems with hookworm larvae, the people themselves are not in actual contact with the soil. Many inhabitants of rural communities, too—persons such as school teachers and plantation owners, who generally live amid good surroundings—showed little infection because their skin did not come in contact with infected soil. Residents of cities with paved streets and latrines were found to be lightly infected unless in recent years they had been workers in the fields.

Slow Acquisition of Hookworm Infection. Theoretically it is possible to acquire massive infection with hookworms following a single exposure; the field studies in Brazil showed that actually this does not occur. They indicated, on the contrary, that the infection is gradually acquired, a worm here and another there, and that many days and weeks pass without any addition to the number harbored. This fact is well illustrated in Fig. 40, which shows by age groups the increase in the number of hookworms harbored by children. Those who begin work in the fields at eight years have an average infection of about fifteen worms each. Until the fourteenth year this infection increases at the rate of about fifty worms a year, or approximately one a week. Children who do not work in the fields gain only one worm every six weeks, or eight a year.

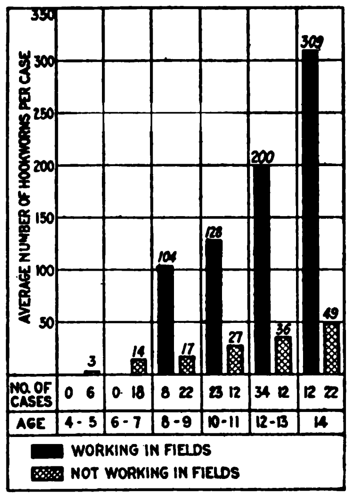

Fig. 40.—Relative intensity of hookworm infection among children working in the fields and those not working in the fields. Classification by two-year age groups. Brazil

At ten years of age, less than half of the children have ten worms each. This means that they have picked up on the average not quite one worm a year. Not a single child of all those examined who were ten years of age or less harbored 150 hookworms. Nevertheless, many of them had been working continuously in the fields and for more than two years had been constantly exposed to the heavily infected soil.

The slow acquisition of the infection was further demonstrated in a group of Japanese colonists engaged in field work in Brazil. Some of them had been working in highly infected soil for about two years, but had only begun to lose the Ancylostomes which they had brought with them from Japan and to acquire the Necators which are common to Brazil. Other Japanese on the same fazenda who had been in

Brazil for more than four years had acquired a large number of Necators, though even by the end of this period they had not acquired so many of the latter species as the average number harbored by native Brazilians who worked side by side with them (Fig. 41). In another instance a woman eighteen years of age who had been a servant in a city home all her life until her marriage to a colonist, when she began to spend some time at work in the field, had not acquired a single hookworm after four months' service, despite the fact that the soil in which she worked was heavily infected.

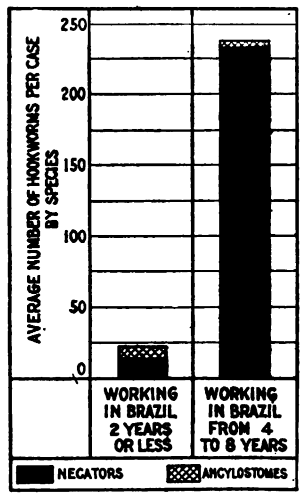

Fig. 41.—Slow acquisition of hookworm infection. It takes Japanese field laborers in Brazil from four to eight years to acquire any considerable number of Necators, the species of hookworm common to the New World

Slow Loss of Hookworm Infection. The infection that is gained so slowly is also slowly lost. This was demonstrated by the following instances. A study of a group of people in a village in the state of Rio gave an average of twenty-eight worms among those who did no field work. Two members of this group, a brother and a sister eighteen and twenty-one years of age, respectively, had worked in the fields from childhood until three years previously, when their father moved to the village, became more prosperous, and provided his children with shoes. The brother and the sister then gave up field work and lived under comparatively good hygienic conditions, but when examined still harbored 318 and 233 worms, respectively. The average infection of field workers in the original district was 390 worms.

In the same village a servant girl of twenty-three years who had left the fields four years previously to work in the kitchen of a wealthy landowner, where she was surrounded by the best sanitary conditions, when examined still harbored 369 worms. Another young woman who, after having worked for years in the fields, had been married three years previously and had since devoted herself to housework, yielded when treated a total of 379 worms.

Effect of Shoes on Infection. Any factor that limits or prevents the contact of bare feet with humid earth should lower the degree of infection. Drs. Darling and Smillie gave attention to the use of shoes as a factor of this kind. In rural Brazil it is almost the universal custom to go barefoot, partly because of the inconvenience which results from wearing shoes and partly because

shoes are so expensive. When working in the field, children never wear them, and adults only rarely.

Groups of adult laborers were studied in three widely scattered localities having conditions practically identical with respect to food, shelter, and type of work. From adult shoe-wearers an average of 27 worms per case was obtained; from barefoot field laborers working side by side with the shoe-wearers, an average of 255 worms per case (Fig. 42). In the family of a Spanish colonist there were six adults who wore in the field a simple, crude, home-made shoe, and four children who went barefoot. From the adults the average number of hookworms obtained was 40; from the children, who should normally have harbored far fewer worms than the adults, 226.

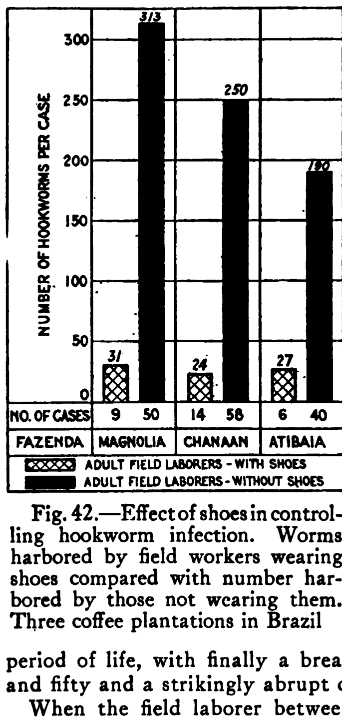

Fig. 42.—Effect of shoes in controlling hookworm infection. Worms harbored by field workers wearing shoes compared with number harbored by those not wearing them. Three coffee plantations in Brazil

Hookworm a Disease of Young Adults. So far as representative Brazilian areas are concerned, the investigations of Darling and Smillie have shown that hookworm disease is a disease of youths and young adults, particularly males. It makes its most severe attack on persons between fifteen and forty-five years of age—in the productive period of life. Fig. 43 shows that the number of worms harbored by males rapidly increases up to the fifteenth year; there is then a gradual, slow, and steady increase throughout the active period of life, with finally a break between the ages of forty-five and fifty and a strikingly abrupt diminution after the latter age.

When the field laborer between twenty and forty-five becomes infected with many more than 200 to 300 hookworms—the average for his age period—he becomes unable to spend so many hours in the field as do his less heavily infected fellow-workmen. His enforced absence from the field for a part of the working day lessens his opportunities for acquiring new infection. A certain number of the worms already harbored die off from natural causes and are eliminated. As the worms cannot multiply within the body, the infection then automatically becomes lighter.

Thus the average infection of 200 to 300 hookworms is maintained for twenty years through the economic necessity of earning a living in

the fields, where the laborer acquires infection, and the necessity of resting at home from his labors because of weakness, where he slowly loses infection. For the body-defense forces the battle is a losing one, however; the break in health and strength finally comes between forty-five and fifty years of age. After the latter age the average laborer in Brazil is old and broken, and to preserve his health must give up a large part of his field work and begin to wear shoes regularly.

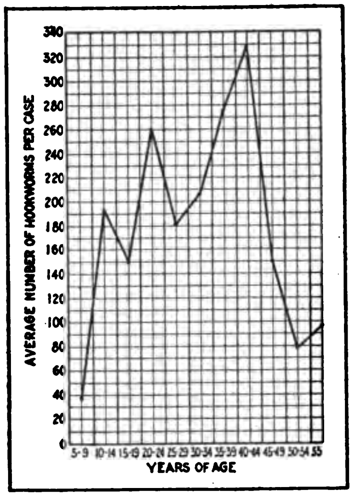

Fig. 43.—Average number of hookworms harbored, by age groups. Based on examination of 381 infected males. Brazil

Comparative Infection among Males and Females. A test which included 562 males and females ranging in age from five to fifty years or more, showed that children under ten years of age harbor very few worms, girls a few less than boys. The next decade showed in both sexes a tremendous increase in worm incidence, as it is the period during which the children go to work in the fields, the girls usually taking up the hoe a little later than the boys and working side by side with them. From twenty to forty-five the average number of hookworms harbored by the men remains very constant and very high, while the average number of worms harbored by the women falls after the eighteenth or nineteenth year, when they usually marry, assume household duties, and thenceforward devote but little time to work in the fields (Fig. 44).

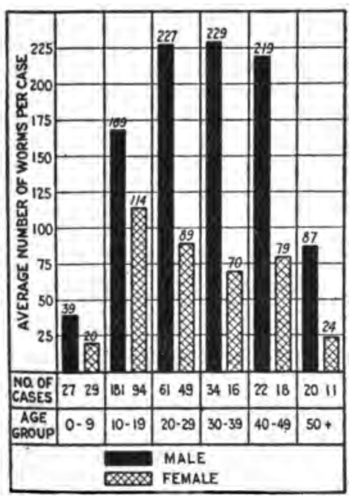

Fig. 44.—Degree of hookworm infection in relation to age and sex. Based on 562 cases. Brazil. Note that females harbor far fewer worms than males

Hookworm Disease in Children. A special study was made of the severity of hookworm disease in children. No children under four were included in the studies and very few under six, because it is difficult to secure all the stools passed by very small children. The test included 246 infected males and 147 infected females ranging in age from four to twenty-four years, and representing all classes of society in Brazil. They were chiefly, however, the children of field laborers. In the main they had never been to school, had never worn shoes, and had always lived within a radius of five miles of their homes. The results were subdivided by sex and tabulated according to two-year age groups (Fig. 45).

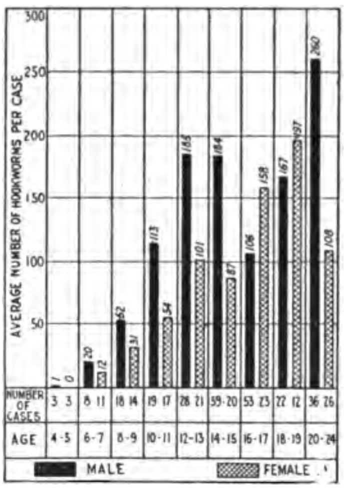

Fig. 45.—Severity of hookworm infection by sex and age groups. Based on worm counts among 393 cases under twenty-four years of age. Brazil

The number of worms harbored was shown to increase gradually and progressively as the person increased in age. Children between four and five had almost no hookworms; those from five to eight, very few. Children over eight who worked in the fields were heavily infected. Among males after the eighteenth to nineteenth year the incidence continued to rise; among females, for the reason previously explained, there was a sudden drop in the incidence.

METHOD OF CONDUCTING WORM-COUNT STUDIES

In conducting worm-count experiments a large number of individuals are registered in the communities selected for study, and their hemoglobin indices are determined with the Dare apparatus. In each community a representative group is then chosen for treatment and further study. This group usually consists of twenty-eight or thirty persons, two thirds of whom are adults over fifteen years of age and one third children from eight to fifteen. Records for each individual give the name, age, sex, occupation, and hemoglobin index; whether or not the spleen is palpable; whether there has been previous malaria or previous anthelmintic treatment; and the results of the preliminary microscopic examination of the stools for hookworm ova.

The first treatment administered to a patient is termed the trial treatment. It varies according to the factors that are to be studied. Ten or fifteen days after the trial treatment, the test treatment is given to remove all of the hookworms that have remained after the trial treatment. An interval of this length should be allowed for the thorough excretion of the medicine administered in the trial treatment. The test treatment is always the same. It consists of a saline purge given at 8 p. m., followed the next morning by 3 mils of chenopodium administered in three equally divided doses, the first at 7, the second at 8, and the third at 9 o'clock. A final purge is given at 10:30 a. m. For children the dose of chenopodium is reduced to 1.5 mils in three equally divided portions.

To facilitate identification and to avoid confusion in handling the stools, each patient who has been treated is tagged on the wrist with a number and receives a chamber-pot which bears the same number. During the treatment careful entry is made of the hour of administration and the amount of the purge, the dosage of the anthelmintic, and the time of treatment. All symptoms, however trivial, are recorded. The entire stools are saved in the numbered chamber-pot for twenty-four hours after treatment, when the patient is given a second pot in which he saves his stools another twenty-four hours. The stools are carefully washed through No. 40 copper gauze on the day when they are received, and all the worms are picked out, counted, and classified.

III

HOOKWORM CONTROL

There are at least two means by which treatment for hookworm disease may be made more readily available to the many million inhabitants of tropical and subtropical countries who are under the burden of a heavy hookworm infection: preliminary microscopic examination can be omitted in regions of heavy infection; and an efficient treatment can be administered as a routine, with the expectation that effective sanitation and post-campaign treatment will eliminate whatever light infection remains.

Impracticability of Insisting Upon Absolute Cure. Large numbers of worm-count studies conducted by Darling and Smillie have shown that two standard treatments (1.5 mils each) of oil of chenopodium remove an average of 95 per cent of the hookworms harbored, and that three treatments remove an average of 98 to 99 per cent of all worms. Further medication to remove the few worms that remain after two or three treatments is hardly worth the effort. Moreover, since it has been shown that diagnosis by microscopic examination fails in about 50 per cent of lightly infected cases, it is difficult to determine accurately whether any worms remain in infected persons who have taken two or more treatments. In view of these facts, several countries have adopted modified working methods to accelerate the rate of treatment.

Experimental Plan of Control for Ceylon Estates. More than 99 per cent of the Tamil laboring population of Ceylon are infected with hookworms. Preliminary fecal examination is therefore omitted in the case of all except 10 or 20 per cent of the laborers on each estate. If the specimens obtained show over 80 per cent infection, the whole labor force, except persons less than a year old, those physically unfit for treatment, and pregnant women beyond the third month, are given one or two medium doses of chenopodium with an interval of one week between. All are examined clinically beforehand to be sure that they are fit to take treatment. Ten days after the first or second treatment, fecal specimens are obtained from all those who have been treated. Persons whom the microscope indicates to be positive after two treatments are given a third treatment.

Modified Control Program in Trinidad and Papua. In certain rural districts of Trinidad where the population is so widely scattered that an intensive campaign would of necessity make its way very slowly, a modified control program has been put into operation for the purpose of rapidly reducing mass infection. A treatment center is established in each district, a census is made of the entire population, and all persons are given one microscopic examination. Those

Fig. 46.—Staff for the relief and control of hookworm disease in Siam. Grouped at the entrance of the temple of Sankampang. Director Barnes stands fourth and Major Luang Boriracksha, a prominent figure in health work in Siam, fifth from the left of first row

Fig. 47.—Lecture on hookworm disease for plantation laborers, Colombia. Field director exhibiting chart on porch

found to harbor hookworms are urged to report for treatment at the community center. Four treatments are administered to each individual. No re-examinations are made, since previous experience in Trinidad has shown that four treatments (thymol is the drug commonly employed) cure 98 per cent of all patients treated.

In Papua, also, a special plan of work has been developed for extending control measures rapidly throughout the island. At the time of the initial survey of each estate an adequate number of sanitary latrines are installed and all laborers are given one treatment. The staff then moves on to the next estate, leaving a supply of anthelmintics in charge of a responsible person, who is commissioned to administer treatment systematically to all natives twice a year. It is believed that this plan will succeed in reducing mass infection, and that subsequently more intensive methods may be applied.

Modified Working Plan Tentatively Adopted for Brazil. In Brazil, too, where more than ten million people, scattered over a vast and sparsely settled area, are awaiting treatment, conservative modification has been made of the plan originally followed. This modified procedure involves a census of the community; one, and only one, microscopic examination of all persons;[1] and two treatments of oil of chenopodium administered with an interval of ten days to each infected person. Individuals with hemoglobin below 60 are treated three times without additional microscopic examination, unless malaria is a controlling factor in the anemia. In addition, all persons suffering from any form of intestinal helminthiasis whatever are treated once, as well as all the members of any family which contains even one infected individual. It is believed that this plan will reach all infected persons and succeed in eliminating at least 95 per cent of the intestinal parasites they harbor. Systematic effort is made during the treatment campaign to secure the construction of latrines at all the homes and to bring the people to understand the importance of using them as a safeguard against re-infection.

Treatment Inadequate as Sole Means of Control. Experience in many parts of the world has demonstrated that hookworm disease cannot be effectively controlled by treatment alone; if the benefits are to be other than transitory, treatment must be preceded or accompanied by adequate precautions against re-infection. This fact has been forcefully demonstrated in Ceylon, Trinidad, St. Vincent, Nicaragua, and various other countries in which control measures have been carried out. Between the years 1904 and 1910 approximately 288,000 Porto Ricans were treated for hookworm disease by the Anemia Commission under Ashford, King, and Guiteras, and striking benefits were conferred over vast areas, but there is still a high incidence of infection in Porto Rico because much

[1] In some sections of Brazil, where, as in Ceylon, there is a uniformly high rate of infection, preliminary microscopic examination is dispensed with, and treatment is carried out on the assumption that all persons are infected.

had to be done in the way of preliminary education before sanitary measures could be introduced.[1]

The history of hookworm work in the republic of Colombia illustrates anew the necessity of accompanying hookworm treatment with preventive measures. Since 1895, spasmodic efforts have been made to relieve the infection through treatment, but they have proved at best merely palliative because of failure to insure the use of latrines. The survey conducted during 1920 brought out the fact that among persons previously treated the infection rate was still 81.7 per cent, as compared with the rate of 76.9 per cent for the general population irrespective of whether they had been previously treated. Treatment of the people is worth while as a means of reducing mass infection and as an educational feature that may be expected to lead to the provision and use of sanitary conveniences; it is inadequate, however, as the sole measure of control.

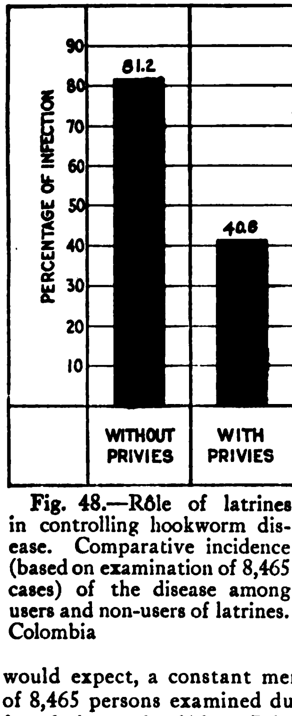

Fig. 48.—Rôle of latrines in controlling hookworm disease. Comparative incidence (based on examination of 8,465 cases) of the disease among users and non-users of latrines. Colombia

Spread of Disease Through Lack of Latrines. In Colombia, despite the fact that intermittent efforts to stamp out the disease had been going on for twenty-five years, more than 95 per cent of the rural homes were found, at the time of the 1920 survey, to be without latrine accommodation. Even in the larger towns—with the exception of Bogotá—there was no established system of night soil disposal: each householder was left to follow his own devices and many of them made not even the slightest pretense at sanitation. The feculent soil that results from such conditions forms, as one would expect, a constant menace to the public health. Of a total of 8,465 persons examined during the progress of the survey, it was found that only 646, or 7.6 per cent, were in the habit of using latrines. Among these persons the rate of hookworm incidence was only 40.8 per cent, as compared with the rate of 81.2 per cent among persons who did not use latrines (Fig. 48). Similarly, the survey of

[1] Through inadvertence, the Fifth Annual Report of the International Health Board, and lithographed report No. 7525 by Dr. John B. Grant, entitled *Hookworm Infection Survey and Malaria Survey of Porto Rico*, did not pay due tribute to the effective work of the early Porto Rico commission. Advantage is taken of this opportunity to correct the omission.

Fig. 49.—Sanitary latrines just completed under supervision of Jefferson county health department. Suburbs of Port Arthur, Texas (see Fig. 50)

Fig. 50.—Insanitary condition of alleys and yards in suburbs of Port Arthur, Texas, before Jefferson county health department began work (see Fig. 49)

Santa Catharina showed that only 57 per cent of the persons who regularly used latrines were infected with hookworm disease, as compared with 87 per cent infection among the persons who did not use them.

None of the numerous tea estates visited in Madras presidency, India, were found to be provided with latrine accommodations for their laborers. Soil pollution was general on all of them and accounted in large measure for the almost universal infection among the laborers. Similarly, in rural districts lying along the littoral of Brazil, where practically all of the people are infected, it is a rare thing for the homes to be provided with latrines. Of 2,875 rural homes inspected in the district of Jacarepagua, located only fifteen miles from the Federal capital, 78 per cent were found to be without latrines at the beginning of control work; and reports from São Paulo, Paraná, Santa Catharina, and other states show similar conditions. In the town of Guaratuba in the state of Paraná, with 600 inhabitants, there was only one latrine, of the pit type. Of 1,423 homes inspected in the municipality of Aguas Virtuosas in the state of Minas Geraes, 88.5 per cent had either no privies or privies inadequate for preventing pollution of the soil.

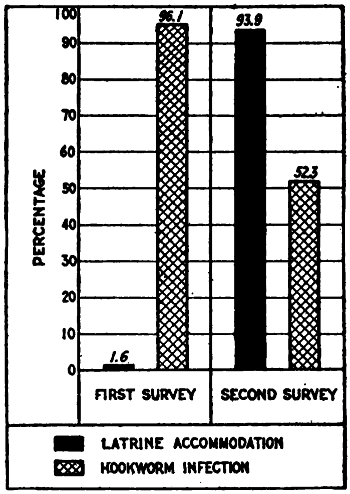

Fig. 51.—Effectiveness of latrines in preventing spread of hookworm infection, Central Mahé area, Seychelles Islands. Compare incidence of infection in first campaign, when there were few latrines, with that in second campaign, when latrine accommodation was almost adequate[1]

Recent Survey of Panama and Colon. The important rôle of sanitation in the control of hookworm infection was well brought out by work conducted during 1920 among school children in the cities of Panama and Colon. In type of soil, in elevation, and in climatic conditions these cities do not differ from the rural regions surrounding them, nor are the habits of their people essentially unlike those of their rural neighbors. From the standpoint of hookworm infection the fundamental difference lies in the fact that since the American occupation in 1904 the cities have had a modern system of sanitation.

[1] The fact that latrines are erected does not guarantee that they will be regularly used. Non-use of latrines on the part of some of the population, or failure to erect the latrines soon enough after treatment in the first campaign, may account for the 52 per cent infection recorded in the second campaign.

Two thousand twenty-one (2,021) children were examined for hookworm disease in these cities. Of these, only 608, or 30.1 per cent, were found infected. This is in striking contrast to the rate of 99.2 per cent established during the past two years by the examination of 8,791 children in interior sections of the republic, where sanitation practically does not exist. When all children who had resided in or visited rural regions were excluded from the city statistics, there remained only 229, or 11.3 per cent of those examined, who had apparently acquired their infection within the city limits. This rate is 88.6 per cent lower than that which obtained among children in other sections of the republic.

Importance of Advance Sanitation. Nowhere has the effectiveness of adequate preliminary sanitation been better demonstrated than in the mines of Australia. Experience with hookworm disease in the mines of America and Europe had caused apprehension lest the deep and warm mines of southern Australia had similarly become infected. The Australian mines present conditions of soil, temperature, and humidity that are favorable for hookworm disease, and have derived at least a part of their labor force from regions of the earth where mine or surface infection is known to exist. Yet the examination during 1920 of over four thousand miners and mine employes in South Australia, Victoria, and New South Wales failed to reveal a single case of hookworm infection. The principal factor which has kept the mines of Australia free from hookworm is the precautions which the mine management and the miners themselves have taken to guard against soil pollution. A system of pail latrines, placed in use when the mines were first opened, has ever since been cleanly maintained and regularly used.

Government Interest in Advance Sanitation. In practically all countries where work is now under way it is not difficult to secure the installation of sufficient latrines, usually in advance of treatment. The next step—to secure and enforce a system of inspection to guarantee their continued use—is less easy. This remains after three years the outstanding problem of the work in Ceylon. The movement for advance sanitation that originated in that colony in 1917 is now making itself felt in Australia, the Seychelles, Papua, the West Indies, Central America, and Colombia. In British Guiana a budget of $100,000 annually for a period of five years has been voted for sanitary improvement and a large part of this will be spent in sanitating areas in advance of hookworm treatment; in Trinidad, £50,000 of a new £1,000,000 bond issue has been allotted for sanitation; in Grenada satisfactory sanitary work is in progress; and in Jamaica and Porto Rico definite provision has been made for preliminary sanitation and for co-operation in control measures. In all countries the practical sanitary work demanded in the hookworm control demonstrations is resulting in the upbuilding of permanent sanitary agencies.

Fig. 52.—Excellent sanitary conditions have prevented hookworm disease from gaining a foothold in the mines of Australia. View of interior of change house, South Mine, Broken Hill, New South Wales

Fig. 53.—Surface latrine showing pails for use underground. Zinc Corporation Mine. Australia. Latrines are used by all employes, underground and surface

Fig. 54.—Department of Soil Sanitation, Republic of Colombia

Advance Sanitation in Colombia. Colombia is now making striking progress in securing the installation and use of latrines in advance of the carrying out of further hookworm examination and treatment. At the beginning of operations, June 14, 1920, only 3 per cent of the 51,911 homes inspected were provided with latrine accommodations of any description; on December 31, 1920, about 50 per cent of these homes were provided with satisfactory conveniences. The total latrines erected during the six-months period numbered 25,246. The plantations made an especially good showing in latrine building, many of them attaining a record of 100 per cent. Staff members were not sent to examine and treat the people in any area until all necessary latrines had been built. So ready, however, were the people to comply with the sanitary regulations that it was impossible to provide dispensary units rapidly enough to keep pace with the program of sanitation.

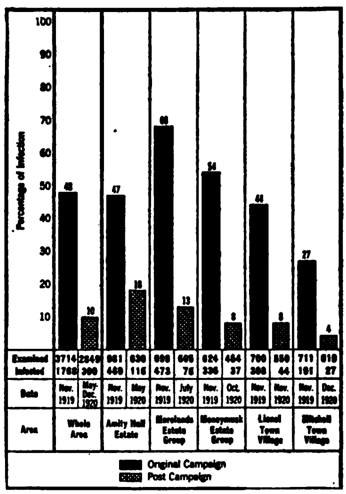

Fig. 55.—Reduction of hookworm infection on five estates of the Vere Area, Jamaica. Comparative incidence of infection in first and second campaigns

Organization of Sanitary Department in Colombia. The sanitary work in Colombia is entrusted to a permanently organized Government department vested with police powers. This division was created by special decree on February 5, 1920. Its personnel, consisting in June of two field directors and eight sanitary inspectors, had by October 15 been enlarged to include seven field directors and sixty-five sanitary inspectors. These men were divided into seven squads to operate in seven provinces, a sanitary inspector being assigned to each municipio (or district) of the province. Government makes latrine construction obligatory upon all proprietors of habitable houses. Failure to construct a latrine within twenty days after notification is punishable by a fine of from twenty to forty pesos. All members of the division have power to impose fines and to make them effective.

Advance Sanitation in Central America. In Nicaragua, at the close of the third quarter of 1920, the work entered definitely on a new phase—that of carrying out curative measures in areas where there had been advance sanitation. In the early work in this country preventive measures were out of the question. In the entire

area where curative work was under way at the close of 1920, 75 per cent of the homes had been provided with a good type of latrine at least six months in advance of the opening of the work. The area wherein operations will be conducted during the first six months of 1921 has already accomplished 90 per cent of privy construction.

In Panama, too, there has been developed a new plan of work whereby the entire staff will be concentrated in one province and sanitary construction will precede treatment. In Salvador the staff has endeavored so far as possible to precede relief measures by sanitary campaigns especially related to the construction of latrines. While progress in the latter country during 1920 has been somewhat slow, it has nevertheless been distinctly more encouraging than in former years. It is unfortunately still necessary to begin curative measures when only three fifths of the homes in an area are provided with latrines, but the provision of even three fifths of the homes with sanitary conveniences is a step in the right direction and the proportion may be increased as time goes on.

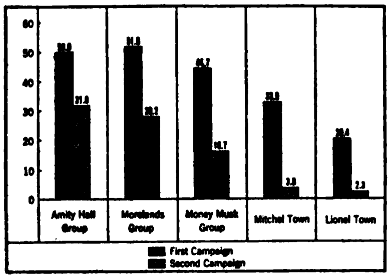

Fig. 56.—Reduction in severity of hookworm infection following control measures. Infected persons who required *more* than two treatments to cure, first campaign and second campaign compared. Five estates of Vere Area. Jamaica

Sanitary Progress in Brazil. Of the eighteen Brazilian areas in which co-operative control demonstrations were carried out in 1920, satisfactory sanitary progress is reported from only four: Jacarepagua in the Federal District, Guaratuba in the state of Paraná, and Itajahy and Florianopolis in the state of Santa Catharina. In the municipality of Jacarepagua all houses near small centers of population now have latrines. The only houses remaining unsupplied are scattered widely throughout the hills on the outskirts of the area. The intensive work in this district closed on June 30, but the sanitary work continues and a permanent force of sanitary inspectors will be maintained indefinitely. By the end of 1921 it is hoped that all permanent habitations in the district will be provided with latrines of one type or another. In the state of São Paulo Government has adopted a sanitary code and will inaugurate at once active efforts to enforce it. Past progress here has been due mainly to the effort of owners of coffee farms, who, oftentimes in advance of the treatment campaign, have made provision for installing latrines.

Reduction of Hookworm Infection. With a view to determining the degree of success achieved by measures for the control of

Fig. 57.—Durable and efficient type of public latrine. Bucket system with concrete superstructure. Heneratgoda, Ceylon. (Note cooly scavenger at work)

Fig. 58.—Well built pail latrine and incinerator. Ceylon

Fig. 59.—Excellent type of pit latrines for estates. Kept lighted at night. Ceylon

hookworm disease, re-surveys have been made from time to time of areas in which operations had been conducted in earlier years. The re-surveys conducted during 1920 in Jamaica and in the county of Escasú, Costa Rica, showed that control operations had effected substantial reductions in the incidence of the disease. On the Veré Estates in Jamaica, at the time of the original campaign in November, 1919, the rate of infection was 48 per cent; at the time of the re-survey in 1920 it was only 10 per cent (Fig. 55, page 85). The infection rate in the county of Escasú was 59 per cent in 1917; in 1920 re-examination of ninety-three persons whose treatment had been completed three years earlier showed an infection rate of 32 per cent—a reduction of 27 per cent.

Twelve representative counties of four southern states were also re-surveyed in 1920. The statistics indicate that the average infection rate of 59.7 per cent which prevailed at the time of the initial survey in 1911 had been reduced to 21.7 per cent at the time of the re-survey in 1920—a reduction of 38.0 per cent (Fig. 16, page 29).

Persons found on a second survey to be re-infected with hookworms harbor a much smaller number of worms than they harbored at the time of their first treatment. Of 286 re-infected persons treated during the second campaign on the Vere Estates in Jamaica, 78 per cent were freed of worms by two treatments, and in not a single instance were more than four treatments necessary (Fig. 56). In the first campaign in this area, on the other hand, the treatment of only 58 per cent of the patients was completed by two treatments, and in some cases it had been necessary to give as many as ten treatments. In the Seychelles Islands, again, 70.8 per cent of the total number of persons freed of worms in a re-campaign were relieved of their infection by two treatments, as compared with only 40.3 per cent in the first campaign one and one-half years earlier (Fig. 60).[1]

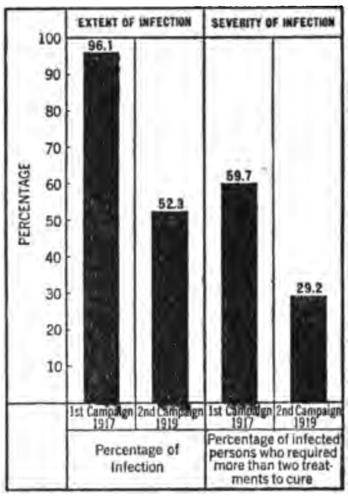

Fig. 60.—Reduction of infection in Seychelles Islands. Incidence of infection in first and second campaigns compared. The lightness of the infection in the second campaign will be seen by comparing the two bars to the right, which indicate the percentage of infected persons who required more than two treatments

[1] All of these re-survey figures are based on search with the microscope for eggs in the feces.

IV

DIAGNOSIS AND TREATMENT OF HOOKWORM DISEASE

Hookworm infection may be diagnosed by administering a vermifuge and searching the stools for hookworms, or by omitting the vermifuge and microscopically examining specimens of feces for ova. It has been customary in field work to rely almost wholly upon variations of the latter method. There are culture methods by which the presence of the infection may be demonstrated, but these are hardly practicable for field use.

DIAGNOSIS BY MICROSCOPIC EXAMINATION

In areas where less than 85 per cent of the people are infected, it is desirable, before administering treatment, to determine whether the infection is present by microscopically examining the feces. Several means of making the examination have been developed, of which the simplest is the plain smear method. This consists of mixing on a two-by-three-inch slide a small portion of fecal matter with a few drops of water, and examining by low power magnification three films made from the mixture.

A more accurate diagnosis can be made with the aid of the centrifuge. When this method is used, a portion of the fecal specimen is thoroughly stirred in a metal cone with five times its volume of water and allowed to settle for a few minutes. Then the supernatant fluid, with ten times its volume of water, is poured into a centrifuge tube and centrifuged rapidly for five minutes. At the end of this time slides for examination with the microscope are prepared from the deposit on the cork of the tube.

Methods of Detecting Ova in Lightly Infected Specimens. Both the plain smear and the centrifuge method, though reasonably dependable when large or moderate numbers of hookworms are harbored, fail to diagnose accurately a considerable proportion of light infections. The need for a microscopic technique which would succeed where these fail has led to the development of a number of methods which secure the concentration of a large number of ova on a slide.

a. Lane levitation method. Clayton Lane recommends a technique which he designates as the levitation method. In this procedure the concentrated sediment of a centrifuged specimen is transferred to a

glass slide, where it is mixed with one mil of water. The slide is allowed to stand for five minutes and is then immersed in water and manipulated until all coarse matter has floated free. The hookworm ova stick firmly to the slide and are not washed away. Lane reports that on an average this method results in a ten-fold concentration of ova.

b. Glycerine-salt method. Barber in the course of his work in the Federated Malay States developed what is known as the glycerine-salt method of examination. In this the fecal specimen is diluted with a fluid composed of equal parts of glycerine and a saturated solution of magnesium sulphate. The mixture is thoroughly stirred and broken up with a toothpick, a process which releases the hookworm ova and causes them to rise to the surface. When the upper part of the fluid in each container is placed on a slide, a large number of ova are brought under the lens of the microscope.

c. Brine flotation-loop method. Kofoid and Barber during their work with the United States Army achieved good results with the brine flotation-loop method of examination. This process demands that a large fecal sample be thoroughly mixed with concentrated brine in a paraffin paper container of from fifty to seventy-five mils (two to three ounce) capacity. The coarse float is forced below the surface by means of a disk of steel wool, and the container is allowed to stand one hour. The upper film is then lifted off with a wire loop one-half inch in diameter and transferred to a slide for examination. The great advantage of this method is believed to lie in its easy utilization of large samples. It eliminates to a large extent the element of random sampling and insures a sufficient number of ova on the slide to make detection possible even when the infection is so light that the ova would be overlooked by other methods using smaller samples.

d. Willis levitation technique. Willis has developed a simplified levitation method which requires no apparatus other than the microscope. This procedure calls for the removal, from the tin in which the fecal specimen has been collected, of enough of the specimen to leave the container not more than one-sixth full. A saturated solution of coarse table salt is then added drop by drop to the specimen until the container has been filled to the brim. The mixture is thoroughly stirred and allowed to stand for a few minutes to permit the ova to rise. A clean polished slide is then placed on the container in contact with the surface of the fluid. In a short time the ova adhere to the slide, which is then removed and placed under the microscope for examination. The advantage of this method lies in its rapidity and in the fact that it secures a good concentration of ova with the use of a small specimen—a factor which makes it suitable for use in field work, especially in remote districts where specimens have to be carried on horseback for many miles.

DIAGNOSIS BY ADMINISTRATION OF VERMIFUGE

The most accurate method of diagnosing hookworm infection is by administering vermicidal treatment and examining the stools for worms. This method is of especial value for determining both the type and the number of hookworms harbored. It is not, however, practicable as a routine field measure. To diagnose infection by this method, it is customary to administer treatment according to the routine method and to save all stools passed by the patient for the succeeding seventy-two hours. The patient should be restrained from eating vegetables with coarse fibres during this period, as these, when passed with the stools, may interfere with the search for worms.

Method of Washing Stools. A regular routine is followed in washing the stools. Those that are soft or fluid are washed at once; the more compact stools are mixed with water and stirred until soft. The washing is done by means of a jet of water played with moderate force into a large brass wire sieve (mesh fifty to an inch) into which the feces have been poured. The washed stool is distributed into photographic developing trays, a small portion into each tray. A dark brown tray furnishes the best background for the worms. The worms are then picked out with needles or with forceps and placed in properly numbered Petri dishes containing normal salt solution. Later the excess salt solution is drained off, and the worms are killed by flooding the dishes with boiling alcohol (70 per cent). After the worms are scalded, they become rigid and assume shapes that are characteristic of their species. This renders differentiation comparatively easy and permits rapid counting of the worms.

TREATMENT OF HOOKWORM DISEASE

Chenopodium is now the definitely preferred anthelmintic for treating hookworm disease. However, it sometimes has an injurious effect upon persons to whom it is administered. Alarming symptoms, and on rare occasions deaths, have been reported from various areas following the administration of the drug in accordance with accepted methods of treatment. Children are especially susceptible to its toxic qualities. Of ten fatalities from chenopodium reported in Brazil during the Board's four years of work in that country, all but one occurred among children ten years of age or less. In Colombia during 1920 seven deaths, all of which were among children, occurred after treatment with chenopodium. It is essential, therefore, that medical officers exercise careful supervision over the use of the drug in the field and that they prescribe for children a dosage smaller than is indicated by Young's rule.

Standard Method of Administering Chenopodium. The standard method of administering chenopodium in field work is that

Fig. 61.—Demonstrating the actuality of hookworms to native peoples. Group awaiting turn to view the worms with the microscopes. Sankampang, Siam

Fig. 62.—Training microscopists for field work. La Mesa, Colombia. Hookworm control operations were inaugurated in this country during the year

recommended by Darling and Smillie as a result of investigations in the Federated Malay States and in Brazil. It consists of an adult dose of 1.5 mils administered in freshly filled hard gelatine capsules. The drug is given in two equal portions, one at 6 a.m. and one at 8 a.m. The last capsule is followed in two hours by a saline purge. No preliminary purge is given. The patient is allowed no food from 8 p.m. of the day preceding treatment until after the prescribed medication has been administered and the purge has acted well. At 7 a.m., however, a small cup of black coffee may be permitted. For children the dosage of chenopodium is graded according to age: those between five and eight years receive one drop of the vermifuge for each year of age; those over eight years are given two drops for each year. The dropper employed is so graded that thirty drops equal one mil.

In the Brazilian experiments one treatment according to this method was found to remove 83 per cent of all hookworms present, and two treatments approximately 95 per cent. The treatment is easily and cheaply administered and produces very little discomfort.

Efficiency of Chenopodium in Undivided Doses. Darling and Smillie found that in so far as single treatments were concerned, the best results were obtained when chenopodium was administered in an undivided two-mil dose, preceded by a saline purge on the evening before treatment and followed two hours after treatment by a similar purge. With this technique 93.8 per cent of the worms harbored were removed by one treatment. Under hospital or dispensary conditions this technique may be employed as easily and as cheaply as the standard method recommended for field use. It causes less discomfort to the patients than other methods, and by its provision for the rapid elimination of the drug it entails less danger of toxic symptoms. It is not, however, adapted to field conditions, especially in sparsely settled rural communities where the administration of a preliminary purge is a difficult and expensive procedure.

Omission of Preliminary Purge with Oil of Chenopodium. Many authorities hold that better results are obtained from chenopodium if a pre-treatment purgative is given. The field experiments of Darling and Smillie, however, have indicated that a preliminary purge, instead of adding to the efficiency of a divided 1.5-mil dose of chenopodium, *slightly* diminishes it in the case of adults. This dosage preceded by a purge was found to remove 90.7 per cent of the worms present, whereas without the preliminary purge it removed 91.0 per cent of all worms. There was relative failure of treatment[1] in 35 per cent of the cases receiving a preliminary purge and in 21 per cent of the cases not receiving one. When smaller doses of chenopodium were given, as in the treatment of children, preliminary purgation *greatly* lowered the efficiency of the drug. A dose of .6 mil preceded by a purge removed only 70.6 per cent of the worms har-

[1] In these experiments a treatment was considered to have failed if it left the patient with ten or more worms.

bored; with preliminary purgation omitted it removed 85.6 per cent. Treatment failed in 100 per cent of the cases receiving a preliminary purge and in only 33 per cent of those not receiving the purge.

When a preliminary purge is administered under field conditions, it frequently so weakens the patient as to unfit him for work the next day, thereby greatly prejudicing him against treatment. Often it causes extreme prostration. In sparsely settled areas its administration is difficult and almost doubles the cost of treatment. It seems advisable therefore to omit preliminary purgation in field work. This was done during 1920 in Brazil, Ceylon, Australia, Salvador, and Guatemala. In none of these areas were there any ill effects or any decrease in the percentage of cures.

Effect of Preliminary Abstinence from Food. Authorities as a rule advise a very light diet during the twenty-four hours preceding treatment. Theoretically, abstinence from food for from fifteen to twenty hours before chenopodium administration should, by leaving the intestinal tract empty, greatly enhance the efficiency of the vermifuge. Field experiments conducted by Darling and Smillie, however, have shown that by far the best results from the chenopodium are obtained when patients are allowed their usual diet on the day before treatment but no food on the morning of treatment. When this procedure was followed and the preliminary purge omitted, 91.0 per cent of the worms harbored were expelled by one treatment (1.5 mils). When patients were allowed no solid food after 11 a.m. of the day before treatment and no nourishment of any kind after 5 p.m., and when the preliminary purge was omitted, one treatment removed 90.1 per cent of all worms. Among persons from whom food was withheld, treatment failed in 60 per cent of all cases, while among those who received an ordinary diet on the day before treatment, there were only 21 per cent of failures. Moreover, prostration and severe toxic symptoms were universal among persons who did not receive food.

In the case of children, who received small doses of the drug, only 35.6 per cent of all worms were removed when food was withheld, and there were 100 per cent of treatment failures; among children who were allowed an ordinary diet, 85.6 per cent of all worms were expelled and there were only 33 per cent of treatment failures.

In field work conducted in Ceylon and the Seychelles Islands, also, it was found that patients who ate an ordinary meal on the afternoon before treatment were much less apt to suffer collapse after the administration of chenopodium than those who were limited to a light repast. Furthermore, there was no diminution in the percentage of cures when a regular diet was permitted.

Simultaneous Administration of Food and Chenopodium. A series of experiments were made by Darling and Smillie during 1920 to determine the effect of administering food coincidently with chenopodium. Patients undergoing this test were subjected to no

Fig. 63.—Group of village headmen assembled to hear a lecture on hookworm disease. Ceylon

Fig. 64.—Eager listeners to chart lecture at Parnassus Creole Barracks. Jamaica

diet restrictions on the day before treatment and received no preliminary purge. On the morning of treatment they received .75 mils of chenopodium at 6 a.m. Between 6:30 and 7 a.m. they were allowed 250 mils of milk, 100 mils of coffee, and 200 grams of bread. At 8 a.m. they received a second .75-mil dose of chenopodium and at 10 a.m. a saline purge. This procedure caused no toxic symptoms nor even the mild discomforts which usually attend treatment with chenopodium, but it greatly lowered the efficiency of the drug. It removed only 56.2 per cent of all worms harbored and failed in 58 per cent of the cases treated.

Magnesium Sulphate Most Commonly Used Purgative. The question as to the best purge for use in connection with hookworm treatment has not been definitely settled. The one most extensively used is magnesium sulphate. The rapidity of action of this purgative has been found to vary in inverse proportion to its concentration. Experience in Ceylon has shown that when a strong solution is administered, catharsis is often delayed until evening of the day of treatment, or even until the next morning. A weaker solution (two pounds of salt to a gallon of water, or about one and one-half drams to the ounce) gives much prompter action and is less apt to cause griping or collapse. The most satisfactory dosage of this weaker solution of magnesium sulphate appears to be two and one half ounces for adult males and two ounces for adult females.

Compound Jalap Powder an Efficient Purge. Washburn reports that in his recent work in Jamaica he used compound jalap powder with much success as a substitute for magnesium sulphate. The drug was given in capsule form, both as a preliminary purge and coincidently with the vermifuge. For the preliminary purge it was mixed with a small amount of powdered charcoal and administered to adults in doses of thirty to forty grains.[1] In the treatment capsule it was compounded with thymol in the same manner and same amounts as milk sugar or bicarbonate of soda. When chenopodium was used, the jalap was placed in the capsule and the oil was dropped upon it. As a preliminary purge, compound jalap powder does not act so rapidly as magnesium sulphate; it can therefore be given on the afternoon instead of the evening preceding treatment, and the nurse is saved the necessity of visiting his patients at night. A final purge is not required when jalap is added to the treatment capsule, and an extra dose of purgative is not found necessary in so many instances as when a single dose of magnesium sulphate is given after vermifuge treatment. The powder is cheaper than magnesium sulphate, easier to administer, and not disagreeable to take.

Castor Oil Used Successfully with Chenopodium. Many authorities have found castor oil a satisfactory purge for use with

[1] The powdered charcoal was mixed with the jalap used in the capsule given for the preliminary purge in order to darken the capsule and thus render it easily distinguishable from the treatment capsule of thymol and jalap.

chenopodium. Salant's experiments showed that the resistance of animals to the toxic effect of chenopodium was much greater when the drug was preceded by a dose of castor oil. Quantities of chenopodium which invariably caused the death of animals when administered without castor oil, were received without symptoms of poisoning when the oil was given shortly before or after the vermifuge. Hall and Wigdor in their experimental treatment of 220 dogs found that when castor oil and chenopodium were administered simultaneously, good purgation was obtained and a high degree of protection was secured against gastro-intestinal irritation and the toxic effects of the vermifuge.

In Nicaragua during 1920 Molloy compared the cases receiving magnesium sulphate after chenopodium with those receiving castor oil. The latter group experienced practically no serious after-effects; in the former, severe symptoms were common. Persons suffering from inanition frequently experienced extreme prostration after taking magnesium sulphate. Following these observations Molloy administered, to all hookworm patients who showed evidence of severe debility, castor oil before, with, and after chenopodium. In less extreme cases of debility he administered chenopodium in half an ounce of castor oil, and gave a small dose of magnesium sulphate two hours after the last dose of vermifuge. Furthermore, he gave a dose of castor oil immediately to all persons who presented symptoms of poisoning following treatment with chenopodium.[1] No serious cases of poisoning occurred after the institution of these measures.

Standard Technique of Thymol Administration. In the countries where thymol is used, the dosage most commonly employed is that recommended by Stiles, Dock, Howard, Bass, and others of wide experience in the treatment of hookworm disease. It is based upon sixty grains as the maximum for an adult, preceded and followed by an active saline purgative. Children from one to five years of age receive from three to five grains of the thymol; those from six to ten, from ten to fifteen grains; and those from eleven to fifteen, from fifteen to thirty grains. Persons between sixteen and twenty years of age receive from thirty to forty grains; those between twenty-one and fifty years, from forty-five to sixty grains; and those more than fifty years, from thirty to forty-five grains. The drug is usually administered in finely powdered form, mixed with equal parts of milk sugar or sodium bicarbonate. It is given in two equal portions, and apparent—not actual—age determines the dosage. Competent physicians examine all patients who are to take the drug, prescribe

[1] It is worth noting, however, that Darling, Barber, and Hacker have reported an experience directly the opposite of that indicated by Salant's, Hall and Wigdor's, and Molloy's results. In their investigations in the Orient they found that when castor oil was used with chenopodium, there was a noticeable increase in dizziness, deafness, and other toxic symptoms, as compared with the symptoms that resulted when magnesium sulphate was used.

the proper dosage for each, and supervise the important phases of treatment.

Conditions Governing Administration of Thymol. Food is not allowed from the time of the first purgative until after the final dose of salts has acted. Inasmuch as alcohol and oils, and gravy, butter, milk, and other fatty foods, are especially dangerous, the patient is cautioned against taking them at any time during the period of treatment. Under field conditions it is generally held that thymol should not be administered to persons suffering from acute diseases, such as malaria in the febrile stage or fevers of any other type; to those having chronic dysentery or diarrhea, organic cardiac or renal disease, pulmonary tuberculosis beyond the incipient stage, or general anasarca; to those who are extremely weak or feeble from old age or from other cause; or to pregnant women or women with serious hemorrhagic diseases of the uterus. Thymol may be administered to persons suffering from any of these diseases only when the circumstances will permit rigid control of all features connected with the treatment.

V

OPERATIONS AGAINST YELLOW FEVER

During 1920 co-operative work against yellow fever was undertaken in Mexico; aid was given in the suppression of epidemics in Central America, in Brazil, and in Peru; sanitary surveillance was maintained to guard against a recurrence of the infection in Guayaquil, Ecuador; and the presence of the disease in West Africa was investigated. Work against yellow fever was therefore under way in every region in which it is known to exist, and steady headway is being made toward its control.

Mexico Undertakes Co-operative Anti-Stegomyia Campaign. Upon invitation of Government a co-operative program for the control of yellow fever in Mexico was adopted toward the close of 1920. A decree issued by the President shortly after the arrival in Mexico City of Colonel T. C. Lyster, director of yellow fever work in Mexico and Central America, authorized the inauguration of control measures throughout the infected districts, provided for the creation of a special yellow fever commission, and set aside 50,000 pesos for carrying out the work. All control operations under the new plan are to center in the Mexican Department of Health. The American personnel will regard themselves as representatives of this department.

During the last six months of 1920 yellow fever existed in Mexico from Tampico to Progreso in the east, and from Hermacilla to Tapachula in the west. This epidemic was checked under the able direction of the national Board of Health. The first efforts under the new co-operative program will be directed toward the points of greatest importance. Late reports indicate that in the first area inspected, a zone 150 kilometers in diameter with Vera Cruz as its center, the incidence of the disease is low.

Yellow Fever Eradicated from Guayaquil. One of the outstanding features of the yellow fever situation in 1920 was the official announcement made in July by the Director of Health of Ecuador that the disease had been entirely eradicated from that country. The infection, which had been present in Guayaquil since 1842, was brought under complete control in that city in June, 1919. Since then no vestige of it has reappeared, and there is every reason for believing that it has been permanently suppressed (Fig. 65). With the disappearance of yellow fever from Guayaquil it is believed that the last endemic focus of the disease in Ecuador has been eliminated. A modern water-supply system is being installed in Guayaquil. Until such time as it is in operation, Government inspectors will guard against a recurrence of Stegomyia breeding by maintaining strict supervision of all water containers. On November 29, 1920, Govern-

ment assumed full responsibility for the continued maintenance of the work, and the Board's representative withdrew from the country.

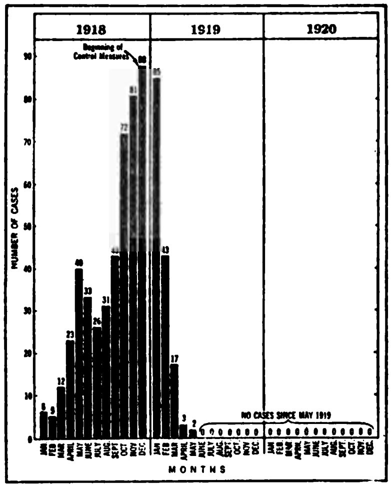

Fig. 65.—Incidence of yellow fever in Guayaquil, Ecuador, 1918–1920. The disease has been completely eradicated from that city as the result of anti-mosquito measures instituted there in November, 1918. Since May, 1919, there has not been a single case

Reappearance of Yellow Fever in Central America. In Central America outbreaks of yellow fever occurred during 1920 in Salvador and Guatemala. A few sporadic cases were reported in Nicaragua. In Salvador the disease was first detected in the coastal plain city of Sonsonate, where a large military detachment recruited from all parts of the Republic had been gathered to suppress a threatened revolution. Many of the recruits had come from high altitudes and were therefore non-immunes. Between May 22 and August 21 there were fifty-six known cases of yellow fever in Sonsonate. The city was placed under strict quarantine, but despite this precaution the disease spread to seven other towns in the department of Sonsonate, to the neighboring departments of Santa Ana and La Libertad, and to Usulután. Meanwhile, smoldering foci of infection which had existed in the city of San Salvador as an aftermath of the epidemic of 1919 flared forth, and the disease spread rapidly to many sections of the city. In the course of the year twenty-five localities of the country were visited by yellow fever, and 181 cases in all were reported (Fig. 68, page 106).

In Guatemala the disease appeared in early June at Los Amates, whither it had probably been carried by an itinerant peddler from Sonsonate. Between June 5 and September 11 fifteen cases were reported. Later nine cases appeared in La Democracia, five in Zacapa, and one in Virginia.

Control Measures in Central America. The health authorities of Salvador and Guatemala at once put forth every effort to suppress these outbreaks, so that by the end of the year yellow fever had almost entirely disappeared from both countries. To insure protection against its recrudescence, anti-mosquito measures will be continued in every area of infection for at least a year after the ap-

pearance of the last case of the disease. Fish control will play a prominent part in these operations.

In Nicaragua and Honduras protective anti-mosquito work was carried on throughout 1920 to guard against outbreaks of yellow fever. During the coming year these precautionary measures will be continued. The Central American countries have taken a determined stand against yellow fever. It seems that their earnest efforts to control the infection must in the end win out.

Suppression of Epidemic in Peru. The elimination of yellow fever from Ecuador left only one center of infection on the Pacific coast of South America—the province of Piura in northern Peru.

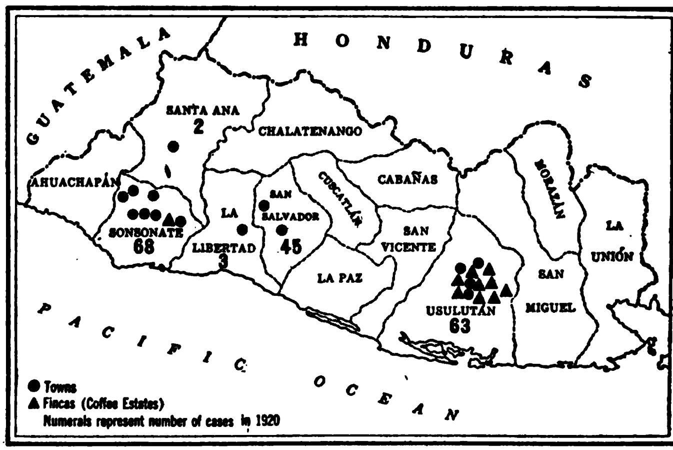

Fig. 66.—Map of Salvador showing location of yellow fever cases in 1920 epidemic

An epidemic of the disease had broken out in that region early in 1919 and had spread to at least ten towns by 1920. The incidence of the infection and the death rate were high. Under the direction of Dr. Henry R. Carter, the Government health service organized energetic measures for the control of Stegomyia breeding throughout the area, and at length succeeded in reducing the Stegomyia index below the danger point. As a result yellow fever had disappeared from the province by the end of October, 1920.[1]

Controlling the Infection in Brazil. While measures were under way for eradicating yellow fever from the west coast of South

[1] In February, 1921, yellow fever reappeared in Peru at a point south of the region previously infected. The disease crossed the desert from Piura and broke forth in several of the rather densely populated coastal towns of the department of Lambayeque. The Board is co-operating with Government in control measures which are being conducted under the direction of Dr. Henry Hanson.

Fig. 67.—Colonel T. C. Lyster, of the Board's yellow fever staff, administering Noguchi yellow fever vaccine. Los Amates, Guatemala

Fig. 68.—Receptacles such as these were a favored breeding place of yellow fever mosquitoes at beginning of control effort in Guayaquil, Ecuador. Fish effectively prevented breeding in practically all these and other miscellaneous water containers

America, the public health service of Brazil was engaged in fighting the infection in the sections of that country where it still persisted. Early in 1919 epidemics of the infection had broken out in six of the northern states of the country. Government organized a central yellow fever commission for combating these outbreaks, and each state where the disease existed appointed a body with similar functions. The various measures which these organizations pursued for reducing the Stegomyia index throughout the infected regions resulted by the end of 1920 in yellow fever in epidemic form being entirely suppressed, and in endemic form being confined to the narrow strip of coastal area between Bahia and Pernambuco. Outbreaks of the disease which occurred in the states of Pernambuco and Sergipe during 1920 were soon controlled, and during the last four months of the year no verified cases were reported from any part of the Republic.

Pursuit of Yellow Fever in Africa. During 1920 a commission visited the west coast of Africa to investigate the nature of a disease which has prevailed in that region for some time and has frequently been reported as yellow fever. The commission, composed of R. E. Noble, M. D., Assistant Surgeon General of the United States Army; Juan Guiteras, M. D., Director of Public Health of Cuba; Adrian Stokes, M. D., Assistant to the Professor of Pathology, Trinity College, Dublin; A. E. Horn, M. D., of the West African Medical Service; and W. F. Tytler, M. D., of the staff of the Medical Research Council in Great Britain, arrived in Lagos, Nigeria, July 17. Here it established headquarters and opened a laboratory. From this point the members carried their investigations into Nigeria, Dahomey, the Gold Coast, Senegal, and Matadi in the Belgian Congo.

Further Study Required to Determine Presence of Infection. A study of such vital statistics and records of epidemics as were available in these localities indicated that yellow fever, or an infection closely allied to it, had existed endemically and epidemically for many years. For the period from May, 1915, to May, 1920, a total of eighty-six cases of yellow fever were reported in the British West African colonies alone. There were also records of epidemics in Dahomey at various times during the period from 1905 to 1917. In the Belgian Congo an outbreak was reported in 1917.

The commission remained in the West Coast area for a period of only fifteen weeks. During the brief time at its disposal it saw no authentic cases of yellow fever, nor was it able to observe any cases of a disease known locally as "shaura," which is reported to exist among the natives and to produce in its acute stages symptoms suggestive of yellow fever. To establish definitely whether this disease is or is not yellow fever, and whether, if it is not, yellow fever is present at all, will require a longer period of time and better facilities for investigation than the commission had at its disposal. Indeed, the task of tracking down yellow fever in this area is likely to prove

a most arduous one and to require prolonged local residence. It will involve following clues to the disease into native villages far from the coast and covering tremendous distances in sections where horseback, hammock, and walking are the only means of travel. The tendency of the natives to hide all cases of disease from the authorities will also complicate the problem. The commission has recommended that another body of investigators be sent to undertake this difficult study and to suggest definite measures for the suppression of the disease if it is found to exist.

Use of Vaccine and Serum in Yellow Fever Control. *Leptospira icteroides* was first isolated by Noguchi in 1918 from cases of yellow fever in Guayaquil. Later (1919) the organism was obtained from yellow fever cases in Merida, Yucatan, and again (1920) in northern Peru by Noguchi and Kligler. Gastiaburu transmitted yellow fever to animals in Piura in 1919. Perez-Grovas, working in Vera Cruz, Mexico, during the summer of 1920, reproduced yellow fever in guinea pigs and obtained a culture. Le Blanc, of the Rockefeller Institute staff, also obtained a strain of the organism from a case of yellow fever in Vera Cruz (1921). The strains obtained by Perez-Grovas and Le Blanc have been found to be identical with the *Leptospira icteroides* isolated earlier.

The killed cultures of *Leptospira icteroides* were first used for protective inoculation against yellow fever in Guayaquil in 1918, where 427 vaccinations were carried out. The results were so encouraging (the morbidity rate among vaccinated and unvaccinated during the same period being 11 and 110 per thousand, respectively) that a vaccine several hundred times as strong has been made in large quantities and employed in Mexico by Drs. Vasconcelos and Casasus of the Consejo Superior de Salubridad; by Drs. Lyster, Bailey, and Vaughn in Central America; and by Drs. Lynn and Guadarrama in Tuxpan, Mexico. The total number of non-immune persons reported vaccinated is about 8,000. The development of protection, as in the case of other vaccines of this sort (anti-typhoid, for example), requires about ten days for completion, persons exposed to yellow fever just before vaccination or immediately afterwards not being protected by vaccination. Excluding such instances, however, there has been no case of yellow fever among the 8,000 persons vaccinated in the various localities, while among unvaccinated persons during the same period and in the same areas there have been about 700 cases of the disease.

The vaccine, by providing immunity, furnishes a rapid method for reducing the number of non-immune persons in areas where yellow fever is epidemic. By the application of sanitary measures to eliminate the mosquito carrier and of vaccination in the meantime to cut off from the infected mosquitoes the supply of non-immune material, a threatening epidemic of yellow fever in Guatemala and Salvador in 1920 is reported to have been checked within one month from the appearance of the first cases; that is, before a second set of cases had

developed. The value of vaccination as an emergency measure does not, however, minimize the importance of the anti-mosquito operations, the elimination of both factors—the non-immune human being and the infected mosquito—being useful in the control of yellow fever.

A therapeutic serum is also available for the treatment of yellow fever. It has already been employed in 152 cases by Drs. Lyster, Vaughn, and Bailey in Central America; by Drs. Vasconcelos and Casasus, Lynn, and Guadarrama in Mexico; and by Dr. Hernandez of the Junta de la Sanidad de Yucatan. Persons treated before the third day of illness have almost invariably recovered, the exceptions being those cases in which the quantity of serum used was too small to have any effect. After the fourth day of illness the injuries to organs are so great as to be irreparable in severe cases of yellow fever. By the use of the serum the usual mortality in yellow fever, 50 to 60 per cent, has been reduced to 9 per cent.

VI

COUNTY HEALTH WORK

In the Southern States demonstration campaigns in the control of hookworm disease have greatly stimulated the development of full-time county health organizations. These agencies seek to do for the rural people what the modern, well-equipped municipal health department does for the population of the larger towns and cities. The importance of this work will be appreciated when it is remembered that 54 per cent of the total population of the United States is rural, and that in twenty-five of the states the rural population comprises more than three fifths of the total.

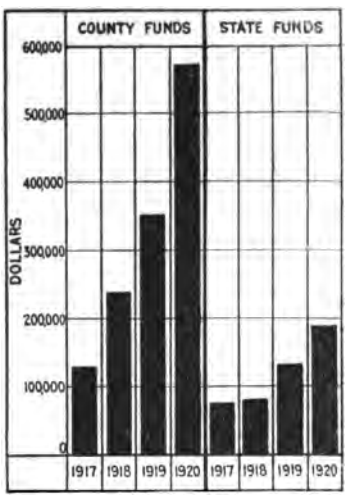

Fig. 69.—Increase in appropriations for county health work. Southern States, 1917–1920

Ninety-seven counties in twelve southern states had, at the close of 1920, full-time health departments. Interest in public health matters has been stimulated, the people are voting taxes as never before for health purposes, and a sanitary sense is beginning to manifest itself. The marked increase in state and county appropriations is exhibited in Fig. 69.

In one of the states county health work has been in progress for more than three years. At the close of 1920 work of this kind was being conducted in twenty-four of its counties having a combined rural population which represented 33 per cent of the state's rural population. A summary of the results accomplished in these twenty-four counties shows 28,345 persons examined and 5,469 treated for hookworm disease; 96,739 vaccinated against typhoid fever and 36,810 against smallpox; 13,670 cases of infectious diseases quarantined; 77,573 school children and 5,780 adults examined for physical defects; and 2,354 public health meetings held, at which the total attendance was 253,488. In addition, 23,547 privies at rural homes were either constructed anew or improved to meet the requirements of the state board of health.

Monthly Report of .... County
to the
STATE BOARD OF HEALTH

February 1920

EDUCATIONAL	
Public meetings	10
Attendance	727
Letters sent	757
News articles (original)	5
News articles (press)	
Office conference, hours	8
Pieces of literature	

SOIL POLLUTION	
Sanitary privies, rural	317
Sanitary privies, towns	
Specimens, stools examined	1
Having hookworm	
Treatments given	
Cured of hookworm	22
Workers employed	
Days worked, total	
Water supplies improved	

SCHOOLS	
Schools visited	14
Cards received	793
Children examined	105
Children treated	2
Sanitary privies installed	
Physical exam teachers	2

DISPENSARIES	
Vaccinations, typhoid	
" smallpox	305
" whooping-cough	

CITY (Special)	
Inspections, hotels, etc.	6
Dairy inspections	
Milk examinations	
Sewer connections	3
Special investigatons	2
Nuisances abated	

QUARANTINE		
Cases quarantined		81
Whooping-cough	REPORTED	13
Measles-German Measles	REPORTED	28/
Diphtheria-S.S. throat	REPORTED	1/
Smallpox-Chickenpox	REPORTED	7/29
Typhoid-Para typhoid	REPORTED	2/
C.S.Meningitis-Inf. paralysis	REPORTED	
Trachoma-Ophthal. neonat.	REPORTED	
Venereal disease	REPORTED	
Scarlet fever	REPORTED	1
Influenza		
Whooping-cough	VISITED	
Measles-German Measles	VISITED	19/
Diphtheria-S.S. throat	VISITED	1/
Smallpox-Chickenpox	VISITED	6/13
Typhoid-Para typhoid	VISITED	
C.S.Meningitis-Inf. paralysis	VISITED	
Trachoma-Ophthal. neonat.	VISITED	
Venereal disease	VISITED	
Scarlet fever	VISITED	1

LIFE EXTENSION	
Applications received	23
Examinations made	25
Midwives instructed	

COUNTY DEPENDENTS	
Visits to county home	1
Visits to county jail	3
Visits to convict camps	1
Patients treated	2
Treatments given	4
Lunacy examinations	1
Physical exam. prisoners	3

NURSES' REPORT (General)	
Number on duty	
Lectures	
Attendance	
Office visits	
Assistance to H.O hours	
News articles	
Letters sent	

INFANT HYGIENE	
Clubs organized	
Clubs visited	
Demonstrations	
Conferences, personal	
Cases visited-mother	
Cases visited-child	
Midwives instructed	
Furnished silver nitrate	
Schools visited	
Children examined	
Ref. to S.B.H. for prenatal letters	
Ref to S.B.H for diet cards	
Ref to S.B.H. for preschool advice	
Sanitary privies	

TUBERCULOSIS	
New cases	
Visits made, instructive	
Visits made, nursing	
Demonstrations	
Conferences, personal	
Sent to physician	
Discharged to sanatorium	
Discharged cured	
Home care only	

Remarks

Fig. 70.—Statistical summary of work of county health department for one month. Indicates range of activities undertaken. Southern States

ACTIVITIES OF COUNTY HEALTH DEPARTMENTS

Fig. 70, page 111, gives a concise statistical summary of the activities of a typical county health department for the month of February, 1920. During the same month there were seventy other county health departments in twelve Southern States engaged in similar activities. It will be seen that attention centers in the prevention of soil pollution and its attending diseases, such as typhoid fever, infant diarrhea, the dysenteries, and hookworm; in life extension work; in the medical inspection and treatment of school children; the quarantine of infectious diseases; the prevention of tuberculosis; and in infant welfare. Effort is made to stress the fundamental principles of healthful living, to develop an accurate system of reporting vital statistics, and to establish at least the nucleus of a public health laboratory service.

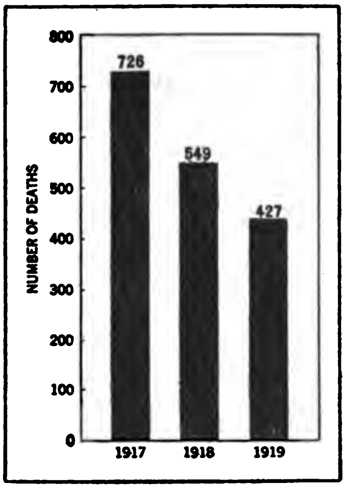

Fig. 71.—Deaths from typhoid fever in North Carolina, 1917 to 1919

Prevention of Soil Pollution. This phase of the work seeks primarily to secure the installation and use of a sanitary latrine at every home. Inspectors of the health department visit the homes throughout the county, make sanitary inspections, and leave behind them plans and specifications for approved latrines. The inspectors later repeat their visits to observe whether the improvement recommended has been made. Their task is simplified in states or communities where there are ordinances requiring the use of latrines; here the inspectors merely see that the law is enforced. The activities against soil pollution also include the making of examinations for hookworm disease and the treatment of those who are found to be infected.

Medical Inspection and Dental Service for Rural Children. The school children of the county are medically inspected in order to obtain a record of the physical condition of every child and treatment for those who need it. The teachers insert on the record card for each child the date of birth, age on entering school, grades repeated (if any), history of diseases in family, the child's height, weight, and chest expansion, the condition of his teeth, eyes, ears, and throat, and the

Fig. 72.—Preventing pollution of the soil is a leading feature of county health work. Corrugated iron lining for pit latrines, adopted for use in Grenada county, Mississippi. In soils with ground-water level near the surface it is necessary to line the pits

Fig. 73.—Inexpensive superstructure erected over lined pit. Grenada county, Mississippi

state of his nutrition. The completed cards are then transmitted to the health officer, who carefully considers each case and examines every child whose card indicates it to possess a remediable defect or abnormality. The examination is made preferably in the presence of the parents, so that the health officer may discuss with them the advisability and the best methods of having the child treated.

The health departments make special effort to educate parents regarding the dangers of dental defects in their children and to impress upon them the importance of having these defects remedied. Traveling dental clinics are provided for rural school children. The great majority of the patients reached by this service are very young children who have never before visited a dentist.

Infant Welfare. This division of the work seeks to lower the death rate among babies and young children by systematically instructing mothers in the principles of infant and child hygiene. The nurse who conducts this unit of work holds clinics at the health office and at other places throughout the county, and gives a course of intensive study to clubs and other women's organizations. Literature for the study course is provided by the state board of health. A clinic conducted by the health officer concludes the course. The nurse arranges to meet the club once a month thereafter for the discussion of community health conditions and for consultations with mothers. She endeavors to give personal instruction to all expectant mothers, to mothers of bottle-fed babies and of babies with diarrhea, and to persons living in homes where tuberculosis exists. She is also charged with supervising and instructing midwives.

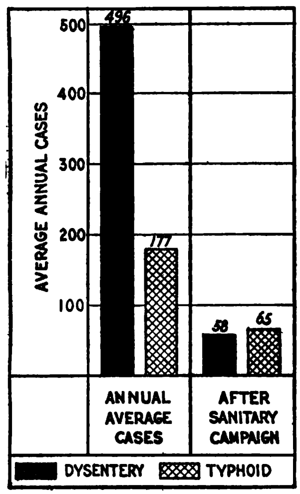

Fig. 74.—Reduction in average annual number of cases of dysentery and typhoid. Situation in Troup county, Georgia, before and after inauguration of county health work compared

Life Extension. The life extension work has proved very popular and has served as a means of enlisting the interest and co-operation of influential citizens. It consists of making thorough physical examinations of adults. The work is intended primarily for persons who are well, and its object is to keep them at their highest state of efficiency. Periodic medical examinations will often detect latent or incipient impairments in health, find minor defects which injure the citizen and decrease his working capacity, and so make it possible

for him to secure medical attention before the condition becomes serious or permanent. The examinations, which include urine and blood-pressure tests, are made in the health office. Treatment is never given. If medical or surgical attention seems advisable, the patient chooses his own physician. Each person receives, however, oral and printed advice and appropriate health literature.

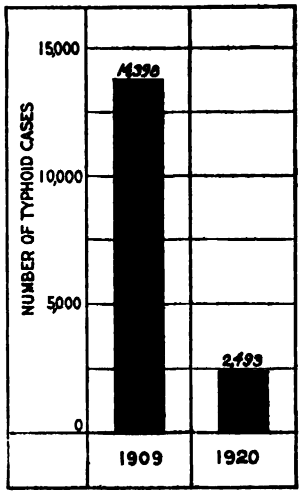

Fig. 75.—Cases of typhoid fever in Virginia, 1909 compared with 1920

Control of Communicable Diseases. This is effected through the state quarantine law, which usually requires the attending physician or the householder to report acute infectious diseases. The health department, upon receiving these reports, sends literature on the disease to the householder and to the school teacher in the district wherein the home is located; and the health officer visits the homes of as many as possible of the cases to give personal instruction in the means of preventing the spread of the disease. Usually the county health office keeps a record of each case reported, transmits notices and detailed monthly reports to the epidemiologist of the state board of health, submits to the newspapers monthly articles on the quarantine work of the county, and publishes in the papers the name and address of each case of communicable disease reported.

EDUCATING THE PUBLIC IN HEALTHFUL LIVING

The work of the county departments always stresses the educational phase. The health officer and his assistants try to present the facts of public hygiene and sanitation in such way that they may benefit every citizen in the county. Lectures and demonstrations, newspaper articles, literature, clinics, and consultations in house-to-house visits form the main channels through which the public is reached. The schools invariably receive special attention, catechisms and similar material on hygienic topics being frequently prepared for use in them. In certain southern counties, as a result of health teaching, the schools have formed organizations to look after the sanitary condition of the school district and to make reports to the health officer.

Fig. 76.—Anti-plague work, Beaumont, Texas: to the left, rat catcher starting out on daily rounds; to the right, rat catchers returning with their catch. A special activity of a Texas county health department

Fig. 77.—Advertising the county health department. Sign board displayed at Logan, the county seat of Logan county, West Virginia

Other publicity devices which have been used with much success consist of health slogans painted on mileposts on the county highways, of weekly bulletins distributed through the county, of letter seals for the use of the department of health, and of exhibits at the county fairs. When the milepost sign is used, two advertisements on each post defray the cost of erecting the posts. In certain instances a contest is held to secure effective sentences for use as slogans. When this is done the business men of the county sometimes agree to furnish the necessary prizes; and men, women, and children in every part of the county take part in the contests. By means of the signs it is possible not only to foster county pride and spirit, to aid visitors, and to advertise the merchants of the county, but also to drive home through repetition the need of preventing disease and the methods by which this may be accomplished.

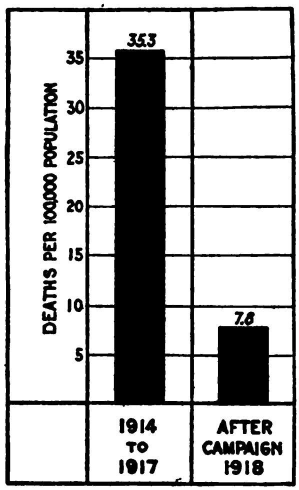

Fig. 78.—Deaths per hundred thousand from typhoid fever, before and after inauguration of county health work. Nine North Carolina counties

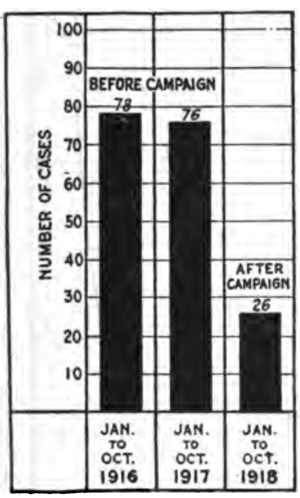

Fig. 79.—Comparison of typhoid cases before and after county health work. Wicomico county, Maryland

REDUCTION IN INCIDENCE OF DISEASE

The most direct evidence of the effectiveness of county health work is to be found in the lowering of sickness and death rates. In North Carolina the number of cases of typhoid fever was reduced from 726 in 1917 to 427 in 1919. This represents a decrease from 29.6 to 16.9 per 100,000 in the typhoid death rate. For each death from typhoid fever it is estimated that there are on the average ten cases, and each case is

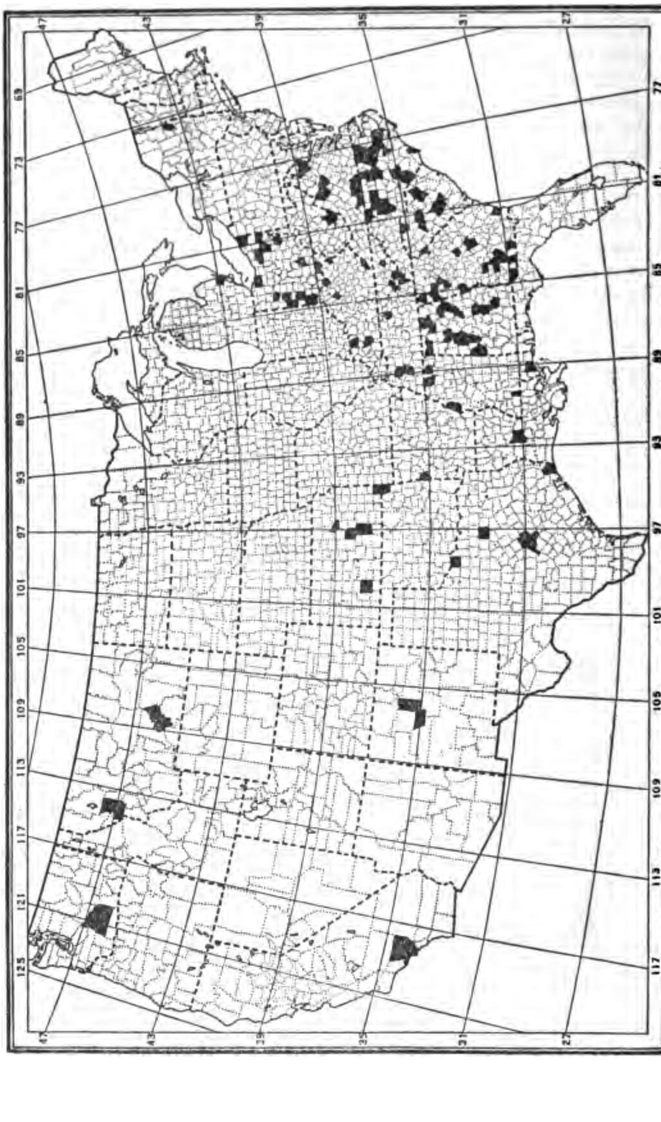

Fig. 80.—Counties or rural districts of United States having health departments with a whole-time health officer in charge. On December 31, 1920, there were 126 of these departments in the country

estimated to cause a loss to the state of not less than $400. In Monroe county, Mississippi, where 8,465 persons were inoculated for typhoid fever between 1918 and 1920 and a total of 1,811 sanitary privies were installed during the same period, the typhoid cases in 1920 numbered 89.8 per cent less than in 1917. Figs. 18, 71, 74, 75, 78, and 79, pages 31 and 112 to 119, depict graphically the reduction in various diseases that has occurred in states in which county health work has been conducted.

EXTENSION OF WORK TO OTHER STATES

The plan of work in operation in the Southern States is applicable to other sections as well. It is, in fact, already being adopted by states in other sections. There were in the country on December 31, 1920, not less than one hundred twenty-six rural counties or districts having county health departments each with a whole-time health officer (Fig. 80, page 120). Kansas and New Mexico are among the latest states to establish such departments.

TABULAR SUMMARY

TABLE 1: All Countries—Persons Enumerated in Census, Microscopically Examined, Found Infected, Given First Treatment, and Cured of Hookworm Disease in Areas Completed during 1920, by Geographical Regions. Figures Excluded for Areas in Which Work Was Still in Progress

Geographical Region	Census	Microscopically Examined		Found Infected		Given First Treatment		Cured	
		Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent
Total	..	..	..	..	..	**292,567**	..	**189,628**	**64.8**
Southern States[1]	..	19,460	..	5,688	29.2	6,471[2]	..	22	0.3
West Indies	29,138	28,890	99.1	16,067	55.6	15,274	95.1	12,867	84.2
Central America[3]	164,654		85.2	78,580	56.0	67,963	86.5	31,093	45.7
South America	120,366	110,192	91.5	84,406	76.6	74,400	88.1	49,330	66.3
The East[4]	..	..	..	..	..	128,459	..	96,316	75.0

[1] During 1920, in the Southern States, the main emphasis in work against soil pollution diseases was placed on the building and improving of latrines.

[2] Some of the persons treated were found infected during 1919.

[3] In Central America the bulk of the work is by the dispensary plan. This does not afford opportunity for frequent re-examinations to determine cure. Consequently the percentage of persons known to be cured is low in comparison with that for other regions.

[4] In Ceylon, throughout 1920, estate laborers were assumed to be infected, and accordingly were given first treatment without preliminary microscopic diagnosis. This explains the blank spaces for "Census," "Microscopically Examined," and "Found Infected" in the lines for "The East" and "Total."

TABLE 2: Southern States—Persons Enumerated in Census, Microscopically Examined, Found Infected, Given First Treatment, and Cured of Hookworm Disease in Areas Completed during 1920, by States. Figures Excluded for Areas in Which Work Was Still in Progress[1]

State	Census	Microscopically Examined		Found Infected		Given First Treatment		Cured	
		Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent
Total	..	**19,460**	..	**5,688**	**29.2**	**6,471**[2]	..	**22**	**.3**
Alabama	..	504	..	381	75.6	516	..	8	1.2
Georgia	..	397	..	236	59.4	236	100.0	..	..
Mississippi	35,724	13,943	39.0	4,452	31.9	4,452	100.0	2	[3]
South Carolina	..	3,408	..	578	17.0	1,237[2]	..	..	..
Tennessee	9,928	644	6.5	28	4.3	20	71.4	5	25.0
Texas	467	257	55.0	12	4.7	9	75.0	6	67.7
Virginia	2,839	307	10.8	1	0.3	1	100.0	1	100.0

[1] During 1920, in the Southern States, the main emphasis in work against soil pollution diseases was placed on the building and improving of latrines.
[2] Some of the persons treated were found infected during 1919.
[3] Less than one-tenth of one per cent.

TABLE 3: West Indies—Persons Enumerated in Census, Microscopically Examined, Found Infected, Given First Treatment, and Cured of Hookworm Disease in Areas Completed during 1920, by Countries. Figures Excluded for Areas in Which Work Was Still in Progress

Country	Census	Microscopically Examined		Found Infected		Given First Treatment		Cured	
		Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent
Total	**29,138**	**28,890**	**99.1**	**16,067**	**55.6**	**15,274**	**95.1**	**12,867**	**84.2**
Jamaica	13,889	13,748	99.0	3,915	28.5	3,605	92.1	3,203	88.8
St. Lucia	6,401	6,373	99.6	4,743	74.4	4,656	98.2	4,261	91.5
Trinidad	8,848	8,769	99.1	7,409	84.5	7,013	94.7	5,403	77.0

TABLE 4: Central America—Persons Enumerated in Census, Microscopically Examined, Found Infected, Given First Treatment, and Cured of Hookworm Disease in Areas Completed during 1920, by Countries. Figures Excluded for Areas in Which Work Was Still in Progress

Country	Census	Microscopically Examined		Found Infected		Given First Treatment		Cured[1]	
		Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent
Total	164,654	140,318	85.2	78,580	56.0	67,963	86.5	31,093	45.7
Costa Rica	43,134	36,454	84.5	10,743	29.5	8,966	83.5	4,768	53.2
Guatemala	22,887	21,460	93.8	12,805	59.7	11,429	89.3	6,777	59.3
Nicaragua	45,160	33,128	73.3	25,272	76.3	22,035	87.2	8,395	38.1
Panama	14,392	13,104	91.1	10,050	76.7	8,353	83.1	4,009	48.0
Salvador	39,081	36,172	92.6	19,710	54.5	17,180	87.2	7,144	41.6

[1] In Central America the bulk of the work is by the dispensary plan. This does not afford opportunity for frequent re-examinations to determine cure. Consequently the percentage of persons known to be cured is low in comparison with that for other regions.

TABLE 5: South America—Persons Enumerated in Census, Microscopically Examined, Found Infected, Given First Treatment, and Cured of Hookworm Disease in Areas Completed during 1920, by Countries. Figures Excluded for Areas in Which Work Was Still in Progress.

State and Country	Census	Microscopically Examined		Found Infected		Given First Treatment		Cured	
		Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent
Total	**120,366**	**110,192**	**91.5**	**84,406**	**76.6**	**74,400**	**88.1**	**49,330**	**66.3**
Brazil	112,488	103,329	91.9	78,363	75.8	68,706	87.7	44,977	65.5
Federal District	18,163	16,961	93.4	11,579	68.3	10,583	91.4	5,179	48.9
Minas Geraes	12,563	11,534	91.8	5,068	43.9	4,632	91.4	2,866	61.9
Paraná	24,506	22,410[1]	91.4	17,329[1]	77.3	14,486	83.6	9,391	64.8
Rio de Janeiro	31,897	28,814[2]	90.3	25,626[2]	88.9	22,672	88.5	15,471	68.2
São Paulo	25,359	23,610	93.1	18,761	79.5	16,333	87.1	12,070	73.9
Colombia	7,878	6,863	87.1	6,043	88.1	5,694	94.2	4,353	76.4

[1] Includes 3,178 not required to submit specimens but examined for treatment.
[2] Includes 7,011 not required to submit specimens but examined for treatment.

TABLE 6: The East—Persons Enumerated in Census, Microscopically Examined, Found Infected, Given First Treatment, and Cured of Hookworm Disease in Areas Completed during 1920, by Countries. Figures Excluded for Areas in Which Work Was Still in Progress

Country	Census	Microscopically Examined		Found Infected		Given First Treatment		Cured	
		Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent
Total[1]	..	..	..	..	..	**128,459**	..	**96,316**	**75.0**
Australia	5,190	5,008	96.5	350	7.0	345	98.6	305	88.4
Ceylon[1]	..	..	..	..	..	117,337	..	95,302	81.2
Seychelles	1,529	1,525	99.7	902	59.1	853	94.5	685	80.3
Siam	23,091	12,591	54.5	10,216	81.1	9,924	97.1	24	0.2

[1] In Ceylon, throughout 1920, estate laborers were assumed to be infected, and accordingly were given first treatment without preliminary microscopic diagnosis. This explains the blank spaces for "Census," "Microscopically Examined," and "Found Infected" in the lines for "Ceylon" and "Total."

FINANCIAL STATEMENT

TABLE 7: Expenditures of the International Health Board Covering its Activities During the Year 1920

Fields of Activity		Amount Expended
Grand Total		**$1,658,269.66**
Relief and Control of Hookworm Disease		623,804.86
Malaria Control		132,118.67
Yellow Fever Control		139,757.40
Tuberculosis in France		518,013.51
Public Health Education		68,553.35
Field Staff Salaries, Expenses, etc., not Prorated to Specific Budgets		25,917.60
Miscellaneous		58,632.07
Administration		91,472.20
Itemization by States and Countries		
Relief and Control of Hookworm Disease		623,804.86
Southern States		144,201.84
West Indies		62,025.73
Central America		97,304.00
South America		206,425.84
The East		113,847.45
Southern States	$144,201.84	
Administration	6,032.20	
Alabama	17,256.72	
Georgia	4,525.39	
Kansas	4,494.00	
Kentucky	16,599.03	
Mississippi	20,709.72	
New Mexico	957.04	
North Carolina	10,463.00	
South Carolina	17,210.63	
Tennessee	13,533.22	
Texas	14,723.99	
Virginia	14,965.17	
West Virginia	2,731.73	
West Indies	62,025.73	
Administration	6,039.23	
British Guiana[1]	486.37	
Dutch Guiana[1]	738.34	
Jamaica	18,400.09	
Porto Rico	7,823.35	
Santo Domingo	1,077.07	
St. Lucia	11,444.57	
Trinidad	16,016.71	

[1] For administrative reasons, British and Dutch Guiana, although on the mainland of South America, are considered West Indian Colonies.

TABLE 7: Expenditures of the International Health Board Covering its Activities During the Year 1920—Continued

Fields of Activity		Amount Expended
Relief and Control of Hookworm Disease—*Continued*		
Central America	$97,304.00	
Administration	7,178.01	
Costa Rica	20,219.60	
Guatemala	17,126.43	
Nicaragua	18,745.12	
Panama	20,061.02	
Salvador	13,973.82	
South America	206,425.84	
Brazil	193,560.95	
Colombia	12,864.89	
The East	113,847.45	
Administration	7,178.01	
Australia	35,417.31	
Borneo	3,106.23	
Ceylon	34,154.28	
India	7,810.00	
Mauritius	5,688.56	
Seychelles Islands	4,643.03	
Siam	15,850.03	
Malaria Control		$132,118.67
Southern States		121,652.24
Foreign Countries		10,466.43
Southern States	$121,652.24	
Administration	6,032.20	
Alabama	8,906.92	
Arkansas	7,048.90	
Georgia	1,230.86	
Louisiana	30,699.94	
Mississippi	27,537.43	
North Carolina	7,526.13	
South Carolina	13,942.74	
Tennessee	1,969.94	
Texas	11,472.34	
Virginia	5,284.84	
Foreign Countries	10,466.43	
Ecuador	4,595.59	
Nicaragua	425.66	
Porto Rico	5,445.18	

TABLE 7: Expenditures of the International Health Board Covering its Activities During the Year 1920—Continued

Fields of Activity	Amount Expended
Yellow Fever Control	$139,757.40
Epidemic work	23,539.03
Ecuador	28,574.98
Salvador	3,926.26
Expenses of Investigating Commissions and salaries, expenses, etc., of Director and Associates	83,717.13
Tuberculosis in France	518,013.51
Central Administration	86,310.57
Medical Division	80,226.08
Public Health Visitation	76,191.46
Educational Division	135,920.64
Departmental Organization	139,364.76
Public Health Education	68,553.35
Department of Hygiene—Faculdade de Medicina e Cirurgia de São Paulo	
Operating Expenses	30,143.51
Fellowships	38,409.84
Miscellaneous	58,632.07
Conference of State Health Officers	2,488.71
Conference of Malaria Workers	1,810.35
Czechoslovakia—Public Health Work	12,708.81
Drugs for Conserving Health of Field Staff	32.29
Express, Freight, and Exchange	557.85
Field Equipment and Supplies	5,996.96
Investigation of Scientific Preparation and Preservation of Powdered Milk	500.00
Medical Examination of Applicants for Field Staff	125.00
Motion Picture Film on Hookworm Disease	2,817.73
Pamphlets and Charts	5,873.33
Paris Conference on an International Nomenclature of Causes of Death	615.30
Repainting Office at Salvador	75.00
Surveys and Exhibits	23,528.78
Survey—Public Health Administration in Massachusetts	1,467.27
Study of Teaching of Hygiene and Public Health in Medical Schools	34.69

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THE ROCKEFELLER FOUNDATION

INTERNATIONAL HEALTH BOARD

EIGHTH ANNUAL REPORT

January 1, 1921—December 31, 1921

61 Broadway, New York, N. Y., U. S. A.

1922

INTERNATIONAL HEALTH BOARD

Report of the General Director

To the President of the Rockefeller Foundation:

Sir:

I have the honor to submit herewith my report as General Director of the International Health Board for the period January 1, 1921, to December 31, 1921.

Respectfully yours,

WICKLIFFE ROSE,

General Director.

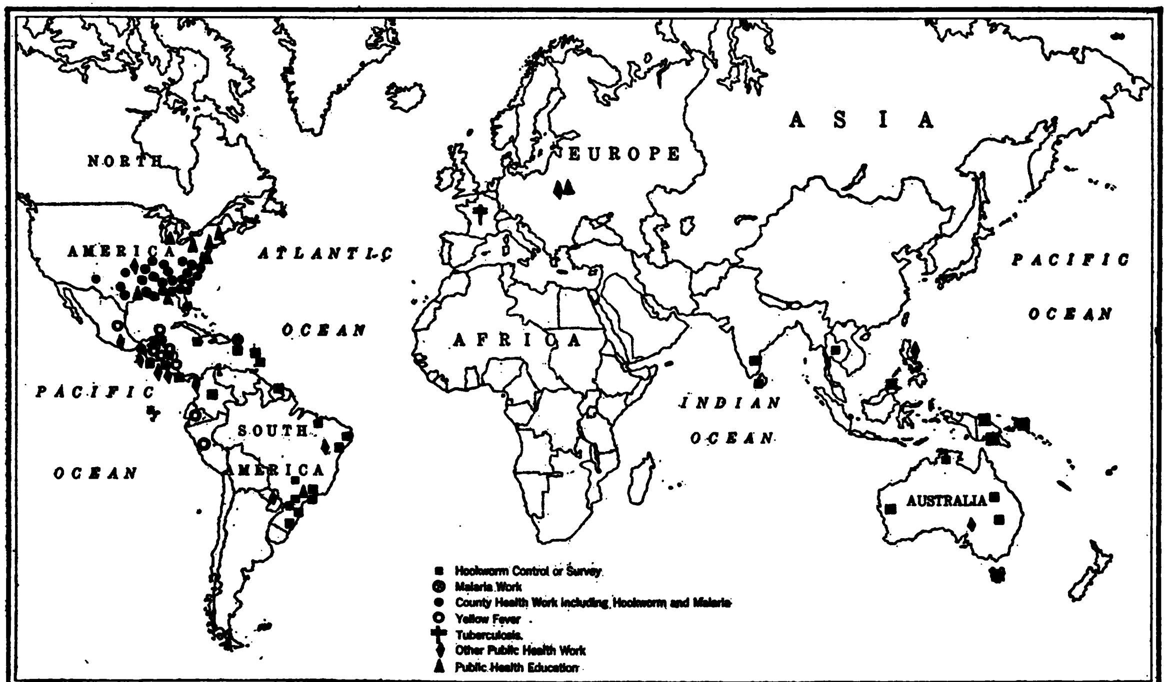

Fig. 1.—Map of world-wide activities of International Health Board during 1921

INTERNATIONAL HEALTH BOARD

OFFICERS AND MEMBERS

GEORGE E. VINCENT, *Chairman*
WICKLIFFE ROSE, *General Director*
HERMANN M. BIGGS
WALLACE BUTTRICK
SIMON FLEXNER
RAYMOND B. FOSDICK
FREDERICK T. GATES
EDWIN O. JORDAN
T. MITCHELL PRUDDEN
JOHN D. ROCKEFELLER, JR.
FREDERICK STRAUSS
VICTOR C. VAUGHAN
WILLIAM H. WELCH

EDWIN R. EMBREE, *Secretary*
FLORENCE M. READ, *Assistant Secretary*

PERSONNEL OF STAFFS DURING 1921[1]

ADMINISTRATIVE STAFF

WICKLIFFE ROSE, *General Director*

JOHN A. FERRELL, M.D., *Director for the United States*

VICTOR G. HEISER, M.D., *Director for the East*

HECTOR H. HOWARD, M.D., *Director for the West Indies*

L. W. HACKETT, M.D., *Associate Regional Director (for Brazil)*

FREDERICK F. RUSSELL, M.D., *Director of Public Health Laboratory Service*

FIELD STAFF

HOOKWORM

AUSTRALIA (including Papua and late German New Guinea)	W. A. Sawyer S. M. Lambert[2] C. N. Leach W. C. Sweet[2]
BRAZIL	L. W. Hackett G. K. Strode Paes de Azevedo (resigned)
Alagoas	F. L. Soper (survey) Alan Gregg
Espirito Santo	G. K. Strode Alan Gregg (survey) J. H. Janney[2] (survey)
Pernambuco	Alan Gregg F. L. Soper
Rio de Janeiro	G. K. Strode
Rio Grande do Sul	Alan Gregg F. L. Soper
Santa Catharina	Alan Gregg F. L. Soper
São Paulo	G. K. Strode
BRITISH NORTH BORNEO	C. H. Yeager

[1] Personnel employed by Government in co-operative work not listed.
[2] Special Staff Member.

British Solomon Islands (survey)	S. M. Lambert[1]
Ceylon	W. P. Jacocks G. G. Hampton C. N. Leach S. A. Winsor (resigned)
Colombia	F. A. Miller
Costa Rica	Louis Schapiro J. E. Elmendorf, Jr.
Dutch Guiana	W. C. Hausheer
Guatemala	E. I. Vaughn J. E. Elmendorf, Jr.
India	J. F. Kendrick G. P. Paul
Jamaica	B. E. Washburn
Nicaragua	D. M. Molloy
Panama	F. C. Caldwell
Porto Rico	R. B. Hill
Salvador	C. A. Bailey
Siam	M. E. Barnes H. R. O'Brien[1]
Trinidad	G. C. Payne W. C. Hausheer J. L. Rice[1]

COUNTY HEALTH WORK IN UNITED STATES

Alabama	F. W. Dershimer A. L. McKay (resigned)
Indiana	G. P. Paul
Kansas	A. J. Warren
Kentucky	P. W. Covington

[1] Special Staff Member.

Louisiana	P. W. Covington Hugo Muench, Jr.[1]
New Mexico	J. F. Docherty D. B. Wilson
Texas	A. P. Harrison[1]

MALARIA

Alabama	E. B. Johnson[1] (resigned) William Ropes[1]
Arkansas	F. P. Gilbert[1] L. G. Hastings[1] (resigned) William Ropes[1]
Louisiana	L. J. Petritz
Mississippi	C. C. Bass[1] J. L. Clarke[1]
Missouri	M. F. Boyd
Nicaragua	F. E. Hulse[1]
North Carolina	H. A. Taylor C. E. Buck[1] (resigned) J. J. Mieldazis[1]
Porto Rico	H. W. Green[1]
South Carolina	J. J. Mieldazis[1]
Tennessee	H. A. Johnson[1] N. H. Rector[1]
Texas	E. H. Magoon[1] Geo. Parker[1]
Virginia	E. H. Gage[1] (resigned)

YELLOW FEVER

Yellow Fever Advisory Council[2]

Henry R. Carter, M.D., Assistant Surgeon General, United States Public Health Service

[1] Special Staff Member.

[2] Not Staff Members; appointed to serve in an advisory capacity.

Juan Guiteras, M.D., Secretary, Department of Health and Charities, Cuba
Hideyo Noguchi, M.D., Rockefeller Institute for Medical Research
Joseph H. White, M.D.,[1] Assistant Surgeon General, United States Public Health Service

MEXICO AND CENTRAL AMERICA	T. C. Lyster[1]
British Honduras	E. I. Vaughn
Guatemala	E. I. Vaughn
	H. K. Marshall[1] (resigned)
	T. F. Botello[1]
Honduras	E. I. Vaughn
	C. A. Bailey
Mexico	J. H. White[1]
	B. W. Caldwell[1]
	M. E. Connor
	W. M. Monroe
	E. I. Vaughn
Nicaragua	D. M. Molloy
Salvador	C. A. Bailey
	W. H. Davies[1] (resigned)
PERU	J. H. White[1]

TUBERCULOSIS

FRANCE	L. R. Williams[1]
	Alexander Bruno[1]
	F. Elisabeth Crowell[1]
	B. L. Wyatt[1] (resigned)

SPECIAL

AUSTRALIA—PUBLIC HEALTH ADMINISTRATION

A. J. Lanza[1]—Lent to Department of Health for two years to assist in organization of Department of Industrial Hygiene

F. F. Longley[1]—Lent to Department of Health for two years to assist in organization of Department of Sanitary Engineering

BRAZIL—COUNTY HEALTH WORK

J. H. Janney[1]

PUBLIC HEALTH NURSING SERVICE

Mrs. Ethel Parsons[1]

SCHOOL OF HYGIENE AND PUBLIC HEALTH, SÃO PAULO

W. G. Smillie, Director and Professor of Hygiene

[1] Special Staff Member.

CHINA—SPECIAL SERVICE

J. B. Grant—Lent to Peking Union Medical College as Associate Professor of Hygiene and Public Health

CZECHOSLOVAKIA—PUBLIC HEALTH ADMINISTRATION

S. M. Gunn [1]

PARAGUAY—PUBLIC HEALTH SURVEY

L. W. Hackett

PHILIPPINE ISLANDS—PUBLIC HEALTH SURVEY

V. G. Heiser

ON LEAVE

(for whole or part of year)

W. T. Burres
S. T. Darling [1]
H. H. Howard
J. J. Mieldazis [1]
Louis Schapiro

AT HOME OFFICE

C. W. Wells (in charge of fellowships)
J. L. Hydrick

ENGAGED IN SPECIAL STUDY (Johns Hopkins School of Hygiene and Public Health)

S. T. Darling [1]
J. B. Grant
Louis Schapiro

IN TRAINING

AUSTRALIA	C. N. Leach W. C. Sweet [1]
BRAZIL	J. H. Janney [1]
CEYLON	C. N. Leach
MEXICO	W. M. Monroe
SIAM	H. R. O'Brien [1]
TENNESSEE	H. A. Johnson [1] N. H. Rector [1]

[1] Special Staff Member.

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ILLUSTRATIONS

PROMOTING HEALTH IN MANY LANDS

The period of three years since the armistice has been one of unprecedented activity in government organization for war on disease: new national health services, including new ministries of health, have been created in England, France, Australia, Czechoslovakia, Poland, and the kingdom of the Serbs, Croats, and Slovenes; in other countries national and state services have been reconstituted with enlarged powers and resources; public funds for health purposes have been enormously increased; and the call for qualified men is being met by the establishment of institutions to provide the training required. During the year 1921 the International Health Board has shared in activities designed to promote this movement in sixty-three states and countries throughout the world.

I

International Co-operation in Yellow Fever Control

There are important public health functions which are essentially international in character. No nation acting alone can perform them. Among these is the control of the great epidemic plagues of which yellow fever is a conspicuous example. For more than 200 years prior to the

well established there before being recognized as yellow fever. Because of limited funds and lack of trained personnel, first efforts at control were on an inadequate scale. By March, 1920, the disease had appeared in serious epidemic form over a wide region in the department of Piura and is estimated to have numbered about 6,000 cases before its final suppression in August of that year. Again the infection escaped. Just before its final extinction in Piura it had crossed a desert zone which had been depended upon to protect the region farther south, and under the guise of "acute malaria" had established itself in the department of Lambayeque. With a dense, non-immune population and an extremely high Stegomyia index—from 60 to 100 per cent—it spread with great rapidity. From Lambayeque the epidemic extended south through the department of Libertad with an estimated total of from 10,000 to 15,000 cases.

Fig. 3.—Scene of the violent yellow fever epidemic in Peru during 1921

Controlling the Epidemic with Fish

In February, 1921, Government placed Doctor Henry Hanson in charge of the campaign with full authority. The International Health Board was called upon to supplement available funds. Competent local physicians were enlisted; a limited number of trained inspectors were brought down from Panama; and as rapidly as possible systematic operations were organized to cover not only the infected area but also a considerable barrier zone lying south of the region of known infection. All effort was centered on the control of Stegomyia breeding.

Here as in Guayaquil the result was finally accomplished by enlisting two local species of fish to devour the eggs and larvae of the mosquito. An attempt in the beginning of the campaign to teach the people to prevent breeding on their own premises failed. Everything had to be done by the mosquito squad. Effort to keep water containers covered was equally unsuccessful. Straining the water (which in that dry country was too precious to be turned out) involved an amount of labor that made it impracticable for a region so vast. It was found that by distributing fish—two to four small fish to a container holding ten to fifteen gallons—the problem was simplified by about 75 per cent, with a lower resulting mosquito index than it had been possible to get in any

other way. The 750,000 fish distributed in this drive conquered the epidemic. The last case was reported from Libertad on July 16.

No case has been reported from Piura since August, 1920, and there has been no known case anywhere in Peru since July, 1921. So vast, however, is the region covered by the epidemic and so often has the infection lingered unrecognized in remote communities that one would not venture at this time to declare the country free. As a precaution against the reappearance of the disease the drive against Stegomyia is to be continued up to May, 1922. It will cover the entire region from Ecuador to Callao—a distance of 500 miles—and from the sea back to the mountains—a zone varying in width from fifty to seventy-five miles. If up to that time no case shall have appeared the forces will be demobilized.

Yucatan a Historic Center of Infection

As Guayaquil for more than seventy-five years had served as the endemic focus from which yellow fever has spread from time to time over the Pacific coast, so Merida, in Yucatan, has been regarded by sanitarians as an important seed-bed of long standing from which the infection has been distributed repeatedly throughout Mexico and the Central American countries.

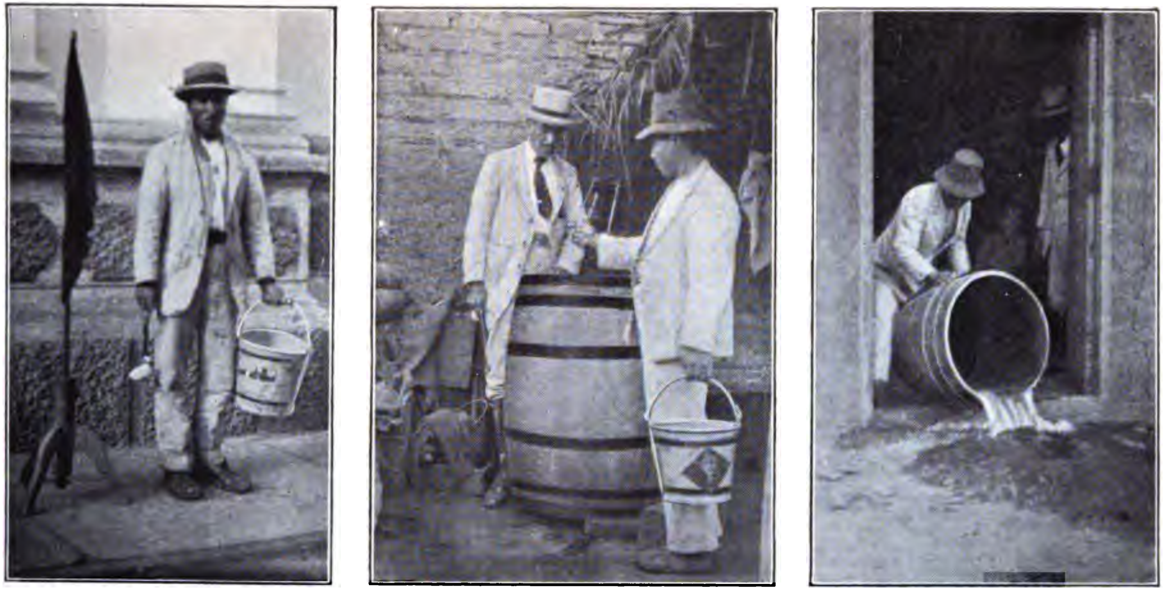


Fig. 4.—Three aspects of yellow fever control effort in Peru during 1921. *Left:* sanitary inspector with equipment carried on his rounds; *center:* stocking a water container with small fish to devour the Stegomyia larvae; *right:* emptying a container as a preliminary to refilling with pure water and stocking with fish

Fig. 5.—A small model showing the types of water containers used about the dwellings in Merida, Yucatan. The exhibition of this model, made of scrap tin by an inspector in his spare time, did much to arouse the interest of householders in preventing mosquito breeding

Fig. 6.—Shallow, driven tubular well for preventing Stegomyia breeding, Corinto, Nicaragua. The placing of fish in the open wells of this town freed the water of larvae, but frequent careful inspection was necessary. The driven well has solved the problem. A small block and platform of concrete are adequate to protect it

Recent archeological studies in Yucatan have given the subject an added interest. They bring to light the records of devastating yellow fever epidemics in the Maya cities of this densely populated region antedating the Spanish invasion. It is to this cause Dr. Spinden[1] attributes the depopulation of these ancient cities and the decay of Maya civilization in the lowlands bordering the Gulf. It is one of the great plagues of the early Spanish records. Throughout modern times it has remained a scourge of this region, with Merida as an important source of infection. Within the last few years the disease has appeared in epidemic form throughout eastern Mexico, on the Mexican Pacific coast from Mazatlán to Guatemala, in Guatemala, Salvador, Nicaragua, Honduras, and British Honduras.

Winning by Team-Play

No one of these countries acting alone could protect itself. The effort was much like attempting to empty a spring with a spoon. Guatemala, for example, suppressed an epidemic which had spread to sixteen communities on the Pacific coast in 1918, only to have the infection reintroduced the following year. Now, by international co-operation, control measures over this

[1] Yellow Fever—First and Last. By Herbert J. Spinden. *World's Work*, December, 1921, p. 169–181.

entire region are being administered as a unit. Active operations in each country are being carried out by a yellow fever commission created by special decree, under the national departments of health and clothed with authority. The necessary unity of effort is secured by the simple device of giving the International Health Board representation on each of these commissions.

This united drive opened in Salvador, Nicaragua, Guatemala, and Honduras in 1920; in Mexico in January, 1921; and in British Honduras in August, 1921. The Mexican department of health had been active on its own account during the previous year and had done much to reduce the severity of the epidemic that had swept over the eastern part of that country from Yucatan to Tampico. In this campaign as in Peru effort is centered on the control of Stegomyia breeding. The problem has been enormously simplified by permanently sealing the domestic tanks and by using larvae-devouring fish in all containers holding sufficient water to support fish life. By the introduction of these two simple devices in Guayaquil in 1919 Dr. Connor had been able to reduce his field staff for a given area from 139 men to twenty men. Experience during 1921 abundantly confirms the result.

War on the mosquito is conquering the disease. At the present time there seems to be no yellow

fever in Merida or anywhere in Yucatan. The important base ports of Campeche, Vera Cruz, Túxpan, and Tampico are being held with a Stegomyia index sufficiently low to prevent the transmission of infection within these communities; and from these centers control measures are

Fig. 7.—Map of Mexico and Central America showing towns visited by yellow fever in 1921

being gradually extended to the outlying communities. A smouldering infection still remains in a back-country region about Papantla; in a densely populated agricultural valley west from Cosamaloapan in the southern part of the state of Vera Cruz; and along the Gulf coast in British Honduras from Belize to Santa Cruz de Bravo in Quintana Roo. Within recent months system-

atic mosquito control has been undertaken on the Mexican Pacific coast, where the infection seems to have been appearing from time to time for the last three years over a vast region from Manzanillo to Mazatlán. These remaining areas of infection should involve no particular difficulties. No case of yellow fever has been reported from Nicaragua, Salvador, Guatemala, or Honduras for more than ten months. The number of cases reported from Mexico and Central America for 1920 was 710; for 1921 the total number of reported cases is 145, as shown in Fig. 8.

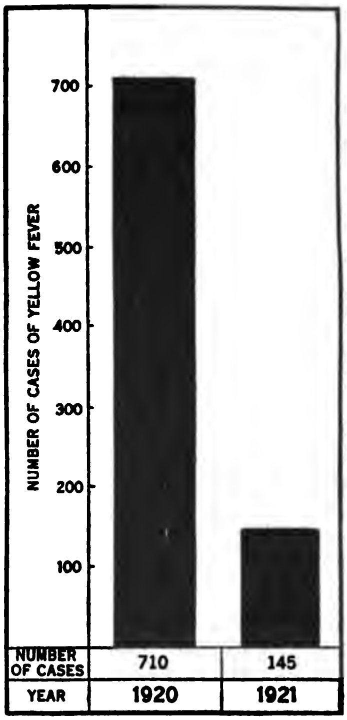


Fig. 8.—Yellow fever cases in Mexico and Central America, 1920 and 1921. Control effort is being continued to stamp out the infection

Government Continuing the Attack in Brazil

The other remaining center of yellow fever on the Western Hemisphere is in Brazil. The infection, formerly covering the entire coast from

Rio de Janeiro north and up the Amazon valley to Yquitos in Peru, seems now to be confined to a narrow coastal zone from Pernambuco to Bahia. These two cities are presumably the endemic foci. In April an epidemic was reported in the state of Bahia. It had apparently been in progress for months, had spread over a considerable area, and numbered from 400 to 500 cases. Cases were reported also from Natal in Rio Grande do Norte, from Porto Calvo, Alagoas, and from the district between Alagoas and Pernambuco.

Until the last vestige of yellow fever has been stamped out here this region must be recognized as a constant menace to the rest of Brazil, to the coasts of Venezuela and Colombia, and to the neighboring West Indies. Freedom from the disease for a considerable period has given opportunity for the development in these countries of a non-immune population. A reinvasion at this time would probably be vastly more disastrous than it could have been ten years ago. The Brazilian national department of health is continuing the fight against the disease in and about Pernambuco and Bahia, and has ample funds for the purpose.

Yellow Fever Commission to West Africa

In 1920 the Board sent a commission to West Africa to determine if possible whether yellow

fever is present in that region, and if so, whether control measures would be feasible. The commission visited the Belgian Congo, Dahomey, Gold Coast, Northern Nigeria, Senegal, Sierra Leone, and Southern Nigeria; saw no case of yellow fever; conferred with medical authorities and examined many records; found strong indications of the presence of the infection within recent years; and recommended that a second commission be sent out prepared to stay, if necessary, for a period of two years for a more extended investigation—this to include a laboratory study of the suspected fevers of the region. The Board has approved. The fixing of the date of departure for this second commission must await the necessary arrangements with governments concerned, the special training of laboratory personnel, and the development of operations in other fields making possible the release of clinical specialists for the staff.

The Noguchi Vaccine and Serum

Killed cultures of *Leptospira icteroides* as a protective vaccine against yellow fever were first prepared and tested by Noguchi in Guayaquil in 1918. The use of the vaccine with laboratory animals had demonstrated its value in producing immunity. During the year 1920 it was used on a considerable scale on human subjects in Mexico

and Central America, and the test was continued during the year 1921 in these countries and in Peru. The cumulative results of the two years' experience tend to confirm the earlier indications. To take a single striking example, Dr. Hanson vaccinated 200 non-immune soldiers in Lambayeque, Peru, and 200 civilians in Paijan. They went through a severe epidemic without a case among them. Continued tests of the therapeutic serum tend also to support the earlier results. When administered in the early stages of the disease it seems greatly to increase the chances of recovery.

II

Extending the Front against Malaria

Despite the economic depression which hit the Southern States with extreme severity, the fight against malaria has been maintained and steadily extended. A series of field experiments carried out in previous years had shown that malaria control in towns having a population of 1,000 or over and representing average conditions in these states is a paying investment. Effort was made during the year 1920 to drive this fact home throughout the more heavily infected region. By joint arrangement state departments of health, local communities, the United States

Public Health Service, and the International Health Board shared in carrying out demonstrations in fifty-two towns in ten states during 1920. In some communities control was effected mainly by the top minnow (*Gambusia affinis*).

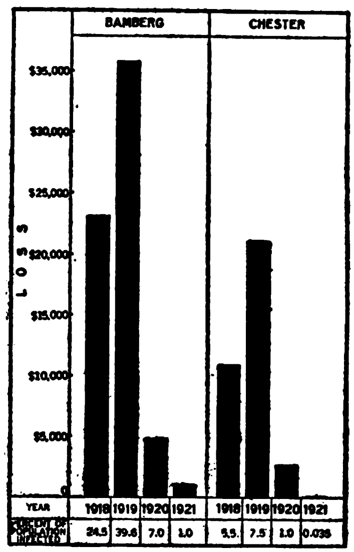


Fig. 9.—What malaria has cost the towns of Bamberg and Chester, South Carolina, during the years 1918 to 1921, inclusive, in the form of wages lost, doctors' bills, and medicines. Combined population, 7,768. Control measures instituted in both towns in 1920 have strikingly reduced this economic loss

Malaria cases in these communities were reduced from 30 to 98 per cent at an average per capita cost of about seventy-eight cents. These results graphically exhibited were given wide publicity. The effect has been the creation of a sustaining and even aggressive public opinion which would seem to guarantee the permanency of the work.

During the year 1921 the service has been consolidated and extended. State and local funds have been increased. Malaria control is being made an integral part of the county health program and the states are assuming the responsibility

for its central supervision. Six states—Alabama, Arkansas, Mississippi, Missouri, South Carolina, and Virginia—have provided central administrative budgets and are appointing specially trained personnel for the purpose. To meet

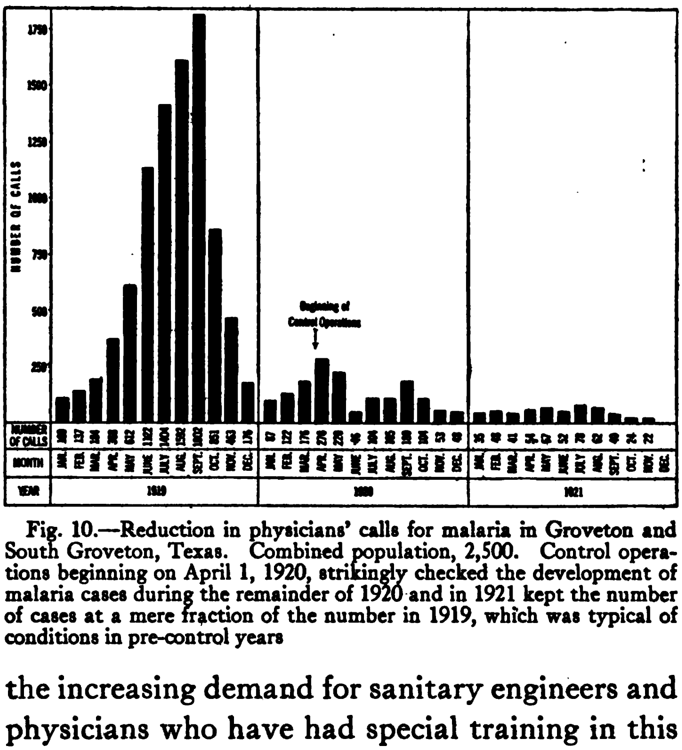


Fig. 10.—Reduction in physicians' calls for malaria in Groveton and South Groveton, Texas. Combined population, 2,500. Control operations beginning on April 1, 1920, strikingly checked the development of malaria cases during the remainder of 1920 and in 1921 kept the number of cases at a mere fraction of the number in 1919, which was typical of conditions in pre-control years

the increasing demand for sanitary engineers and physicians who have had special training in this field, the Board has undertaken to maintain a considerable reserve corps through a period of apprenticeship. On completion of their training they are taken into federal, state, or county service.

Intensive demonstrations have been undertaken during 1921 in twenty-six additional towns. In a number of communities—as in Texas for example—the municipal governments have provided the entire cost of the work save that of general supervision. For typical results see Figs. 9 and 10, pages 16 and 17.

Malaria Control on a County-Wide Scale

Field experiments in which the Board has shared hitherto have had for their object the testing of separate control measures: mosquito control in small towns; mosquito control in a typical rural community; quinine for sterilizing the blood of the infected; protection by the screening of houses. These nibbling efforts have served their purpose. During the year 1921 a major attack against malaria has been opened along the entire front, including town, village, and the open country. The unit of operations is the county. Malaria control is undertaken as a part of the permanent county health scheme; is supported by state, county, and local funds; and is under the direction of the county health officer.

All available measures are employed, each receiving emphasis according to local conditions. In Alabama, where an energetic sanitary engineer is co-operating with the health officers in a group

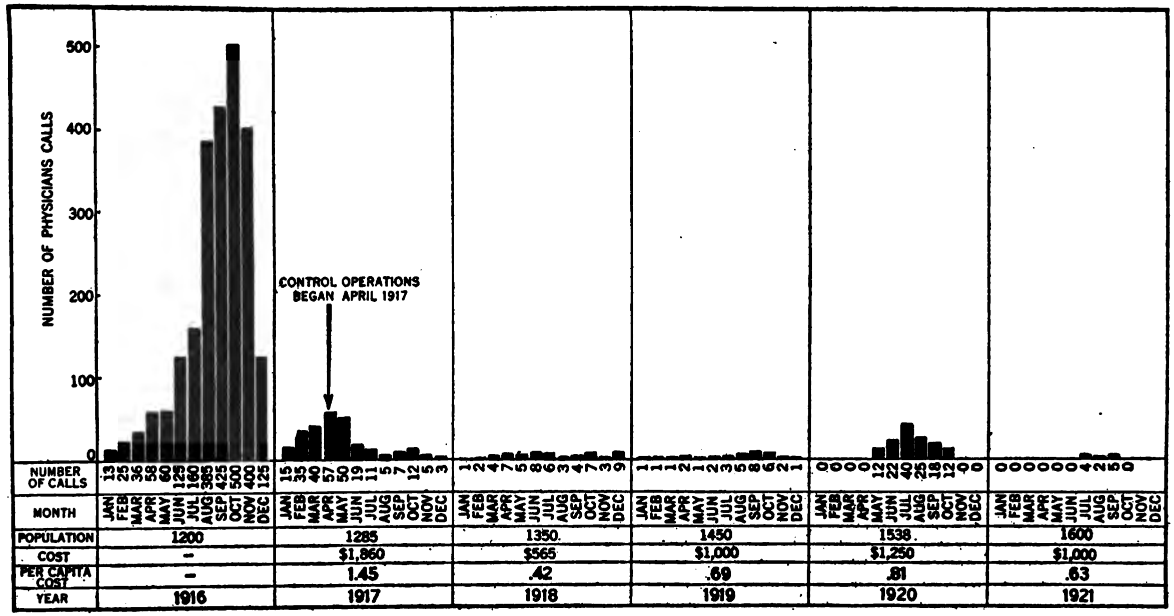


Fig. 11.—Record of malaria incidence for town of Hamburg, Arkansas, which has maintained anti-mosquito measures for five successive years. The work is now regarded as a regular municipal function. This town and Crossett, Arkansas, were the scenes of the International Health Board's first participation in malaria control by anti-mosquito measures

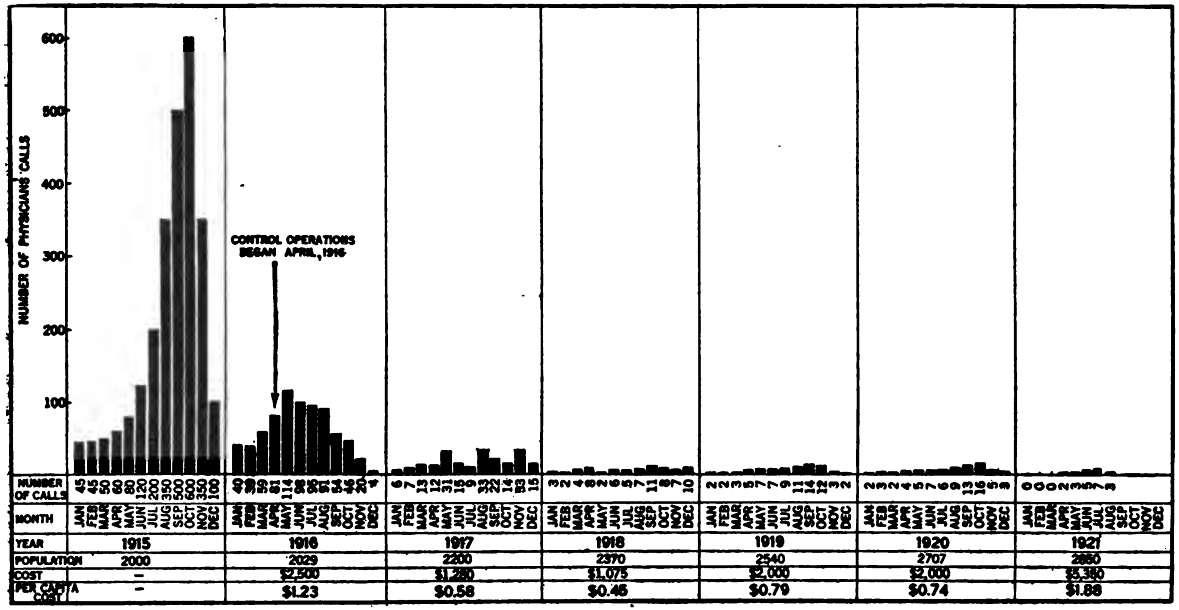


Fig. 12.—How malaria has been brought under control in Crossett, Arkansas. The anti-mosquito measures inaugurated in 1916 have been continued year by year, and in 1921 a system of concrete ditches and culverts was laid. The town is finding it much more economical to protect itself against malaria than to suffer the losses the disease involves

of five counties, mosquito control is being extended to rural communities. The top minnow —shown by Dr. Howard in his experiment in Mississippi to be effective and economical in controlling mosquito breeding about farm houses —is the principal agent here. The farmers are maintaining minnow ponds from which mosquito-breeding waters may be easily stocked with fish. In the Mississippi delta, on the other hand, where mosquito control is less feasible, anti-mosquito measures are not neglected where conditions favor, but greater emphasis is being placed on sterilizing quinine treatment. In all counties where the work has been undertaken the people are being taught to screen their houses as a protection against flies and mosquitoes. The standard quinine treatment for those who have malaria is provided at convenient points and its use is being stimulated by systematic education. This county-wide effort is being undertaken not as a brief intensive drive, but as a slow, steady campaign to be continued over a period of years.

Field Experiments in Malaria Control

A limited number of field experiments are being continued. As a result of Dr. Bass's work in Bolivar and Sunflower counties in Mississippi a standard quinine treatment for malaria in this region has become established and its use is being

gradually extended to other counties and states. At Mound, Louisiana, tests are being carried out with a view to getting additional information on the screening of houses as a factor in malaria control; the effect of the location of houses, in relation to mosquito-breeding places, on the incidence and severity of malaria; effect of killing adult mosquitoes in homes; control of mosquito breeding by top minnows and wave action, in connection with impounding water in bayous and keeping down the marginal vegetation by pasturage. An experiment has been undertaken in Nicaragua to test the control of mosquitoes in a small town, under tropical conditions, by the simple and relatively inexpensive measures that have been successful in the Southern States. A similar test is being conducted in Porto Rico in an agricultural area.

III

Fighting Tuberculosis in France

The commission which the Board sent to France in 1917 to aid in organizing a national crusade against tuberculosis is well within sight of the end of its task. Responsibility is being rapidly transferred to French authorities. When the work began four years ago the French government and people were bearing the burdens of a devastating war and were carrying the additional

Fig. 13.—Tuberculosis exhibit at Pasteur Institute, Paris. Publicity measures are an essential feature of the campaign against tuberculosis in France

Fig. 14.—Traveling educational units have met with marked success in the anti-tuberculosis work in France. Motors cars and a special railway car have been used for transporting personnel and equipment. During 1921 fifteen departments were visited; 1,294 lectures were delivered to audiences aggregating 470,078; and a total of 3,594,500 pieces of literature were distributed

weight of a heavy tuberculosis rate which, as in all the warring countries, was supposed to be on the increase. There were in the country at that time but twenty-two tuberculosis dispensaries, and for persons needing hospital or sanatorium care not more than 8,000 beds.

To meet the situation a great multiplicity of agencies—French and American, official and non-official, military and civilian—pooled their interests in a spirit of team-play that made possible a coherent program. A scheme was projected on a national scale. It undertook to promote the establishment of tuberculosis dispensaries; to develop nursing schools for the training of public health visitors; to provide graduate courses for the training of doctors for the service; to establish a central records and statistical service; to conduct a nation-wide campaign of popular education; and in the end to stimulate the provision of hospital beds and sanatoria for the cases that need such care.

This united effort has met with enthusiastic response. The whole of France has been reached through the press and by literature in the schools. Mobile exhibits with teaching personnel have covered systematically fifty-four departments. In sixty-four departments the usual organization has been set up, providing for the operation of dispensaries and the maintenance of

hospital beds. The national government is granting subventions for the building of sanatoria. Eight training schools for public health visitors are in operation; and of these, five seem to be on a permanent basis. Beginning with 1922 all but one are to offer a two-year course. Diplomas have been given to about 250 women who have completed the course and who are now serving, some of them as departmental supervisors, the others in local dispensaries. The graduate course in tuberculosis, which from the beginning awakened unexpected interest, has been completed by 264 dispensary physicians. All activities undertaken in 1917 may be regarded as rooted in French soil; they are being supported by Government and the people. The commission has been dissolved. Dr. Linsly R. Williams with a limited American staff represents the Board in completing the transfer of responsibility. Comradeship in this service to all who have shared it has been an inspiring privilege.

IV

Using the Hookworm in Promoting Public Health

Of the estimated seventeen hundred million people inhabiting the globe, something more than nine hundred million live in countries where hookworm infection is a serious menace to health and working efficiency. With increasing pres-

sure for the development of tropical and subtropical lands the control of this disease—as of malaria and sleeping sickness—becomes a matter of serious international concern. Hookworm disease has been selected by the Board for special consideration, however, not primarily because of its relative importance as a disabling disease, great as that is, but rather because it lends itself readily to purposes of demonstration in disease control. It serves at once as an end in itself and as a convenient means to a larger end. The work, while bringing immediate relief to hundreds of thousands of suffering people, is at the same time serving the more useful purpose of creating a popular sentiment in support of permanent agencies for the promotion of the public health.

During the year the Board contributed toward demonstrations in hookworm control in forty-three states and countries throughout the infected zone; completed infection and sanitary surveys in the states of Alagoas and Espirito Santo, Brazil, in New Guinea, in the British Solomon Islands, in Tasmania, and in Queensland; and began surveys which are still in progress in New South Wales, in Western Australia, and in Northern Territory, Australia. Arrangements were entered into with Government for a series of demonstrations in Mauritius and Honduras. Re-infection surveys to determine re-

sults of previous work and to serve as a stimulus to further effort were carried out on a county-wide scale in forty-five counties in the Southern United States and in a number of smaller areas in Jamaica and Brazil.

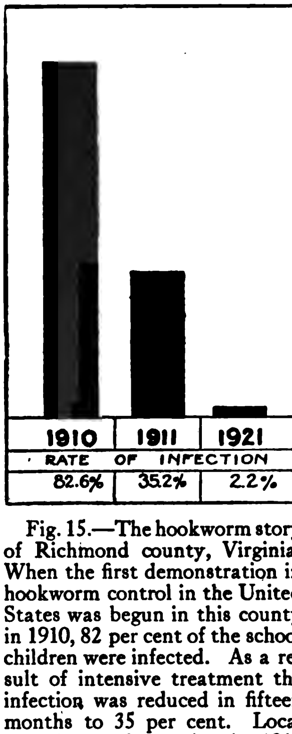


Fig. 15.—The hookworm story of Richmond county, Virginia. When the first demonstration in hookworm control in the United States was begun in this county in 1910, 82 per cent of the school children were infected. As a result of intensive treatment the infection was reduced in fifteen months to 35 per cent. Local agencies set in motion in 1910 have kept up the work until now hookworm infection in that county is negligible

The character of the work and the policy underlying its administration are well illustrated in

The First Field Demonstration

The first systematic effort to control hookworm disease in the United States was undertaken in 1910 in Richmond county, Virginia. It was under the direction of the Virginia State Board of Health, with the Rockefeller Sanitary Commission supplying the funds. An infection survey made in April of that year showed an average infection of 82.6 per cent among the school children. In one large section of the county the infection was found to in-

volve practically the entire population and to be extremely severe. There followed an intensive effort to examine all the people; to treat those who were found infected; and by house-to-house visits to give them a definite understanding of the importance and the means of preventing soil pollution. Sanitary leagues were organized in local communities. Latrines were installed at all the schools and by persistent effort were gradually brought into use at nearly all the homes.

A second survey made in the summer of the following year showed that the infection among the school children had dropped from 82.6 to 35.2 per cent. Then the interesting thing happened. Outside aid was withdrawn; the county and its communities were left to their own devices. A third survey made ten years later—in the summer of 1921—showed that the infection among school children had dropped to 2.2 per cent. The first intensive demonstration in 1910, while reducing hookworm infection from 82.6 to 35.2 per cent, set in motion permanent local forces which within ten years have reduced the infection rate to the negligible fraction of 2.2 per cent (see Fig. 15, page 28).

And while conquering hookworm these same forces are conquering typhoid and dysentery as

well. The recent survey referred to above showed that the people have latrines at their homes and are using them. Only two negro homes, two white tenant homes, and one white home owned by the occupant, were found without such protection. The late Dr. Fisher, who had been a practicing physician here for more than thirty-five years, stated that typhoid and dysentery used to bulk large in his practice. He had not had a case of either of these diseases for more than five years. He also reported—and the statement is abundantly supported by the facts as observed by the General Director, who visited the community in June, 1911, and again in November, 1921—that the economic and social changes which have come within this time are quite as great as the improvement in health.

Results in Eleven States

The service inaugurated in 1910 in Richmond county was extended rapidly to the more heavily infected counties of eleven southern states. Results similar in character—though less on the average in degree of control—have been accomplished throughout this infected region. Resurveys carried out on a county-wide scale, and based on the examination of school children—as were the original infection surveys

of 1911–1914—have been completed in fifty-six counties; more than 29,000 children have been examined in these recent tests. The results show, for the fifty-two counties for which comparative records are now available, a decline in the average infection rate from 57.8 per cent in 1911–1914 to 27.7 per cent in 1920–1921. The change wrought in the physical appearance of the people is obvious even to the casual observer. As in Richmond county, so over the larger region, typhoid and dysentery also are being brought under control (see Fig. 16).

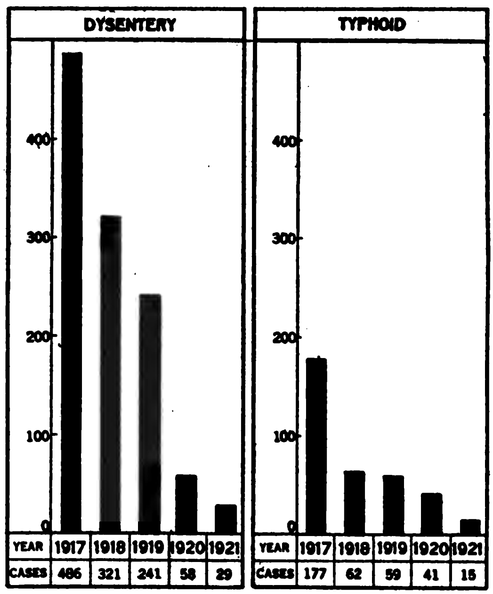


Fig. 16.—Decline in incidence of dysentery and typhoid fever, Troup county, Georgia, 1917–1921, inclusive. The prevention of soil contamination, brought about through the work of the county health departments, accomplishes not only the control of hookworm but of other soil-borne diseases as well

The point to be emphasized is that although the original intensive demonstrations in which nearly

three fourths of a million people were treated in these states contributed to the immediate reduction of the infection both in degree and in prevalence, the results have been accomplished in the main by permanent local agencies rooted in the soil. These forces are continually active, are committed to the task, and may be depended upon to complete it.

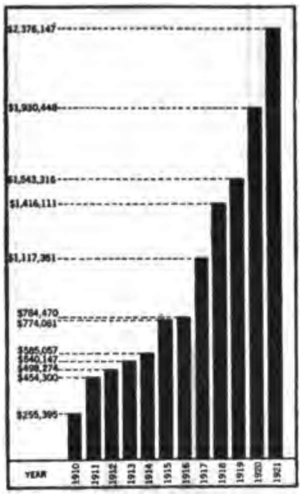


Fig. 17.—Appropriations of legislatures to state boards of health in eleven southern states 1910–1921. Includes funds for anti-tuberculosis work

Board's Work Completed

The object which the Board had in view has been accomplished. During the year the arrangement by which the Rockefeller Sanitary Commission and later the International Health Board had shared with the states in measures for the relief and control of hookworm disease was brought to a satisfactory close. Heads of health departments have seen develop in these states, in response to their efforts, a strong public sentiment in support of sound and aggressive public health policy. State legislative appropriations for health purposes have increased more than

nine-fold during the eleven years (see Fig. 17, page 32). County health departments supported in the main by county funds have developed and are developing more rapidly than it has been possible to provide properly trained men (see Fig. 55, page 112).

Termination of the Board's participation in measures directed specifically to the control of hookworm disease does not disturb working relations with these states. It makes possible rather a transfer of funds to the further development of the more general county health program, to the fight against malaria, and to the training of personnel for the technical and administrative positions which are being created.

Testing Results in Brazil

With a view to testing the effectiveness of field operations in Brazil Dr. W. G. Smillie, Director of the Institute of Hygiene at São Paulo, made a resurvey during the year in two communities within the Federal area. The test was based on worm counts. Though the usual microscopic examination of stools showed but slight reduction in the percentage of persons infected in either of these communities, the number of parasites expelled showed a striking result. In one of the two communities where latrine construction had not been thorough the group that had been treated

at the time of the original demonstration harbored on the average forty-two parasites per person, while a group that had escaped

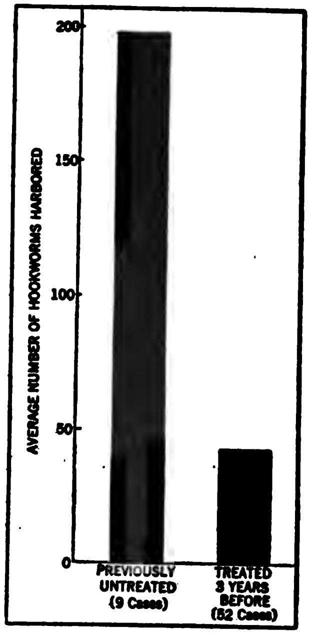


Fig. 18.—Control of hookworm disease as result of campaign measures applied in 1918 in Jacarepagua, Brazil. In that year the infected inhabitants harbored on an average approximately 200 worms; in 1921 they harbored only forty-two

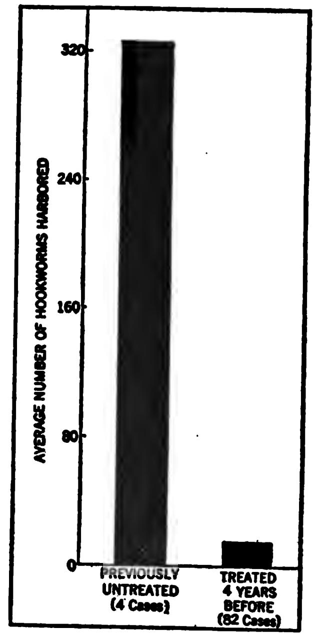


Fig. 19.—Reduction of hookworm disease as result of control measures, Governor's Island, Brazil. (In this graph and in Fig. 18 the cases represented by the bar "Previously Untreated" are few in number because the population of both places is largely transient. No considerable number of persons could be found in 1921 who had lived there and had not been treated at the time of the original campaigns in 1917–1918)

treatment averaged approximately 200,—a reduction of 79 per cent. In the other community where latrine construction had been more thorough the test indicated that the original campaign, with

the continued operation of local forces, had within four years' time reduced by 95 per cent the number of hookworms harbored (see Figs. 18 and 19, page 34).[1]

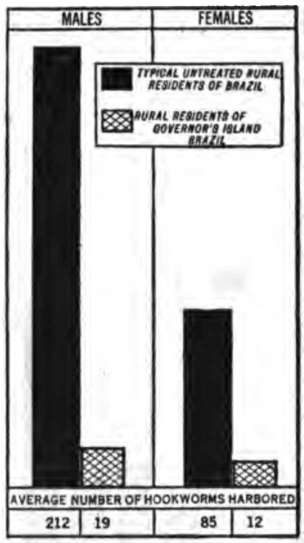


Fig. 20.—Effect of treatment and the installation of latrines on severity of hookworm infection. Worms harbored by typical untreated rural residents of Brazil compared with those harbored in 1921 by the rural residents of Governor's Island, who were treated three years previously

Transferring Responsibility to Brazilian Government

The work inaugurated in 1916 in the state of Rio and rapidly extended to the Federal area and eleven states is being taken over by government authorities as part of a permanent scheme of rural sanitation. For this purpose appropriations, state and federal, have increased from $12,556 in 1917 to $2,072,500 in 1921 (see Fig. 21, page 36). The Board is gradually transferring its funds from demonstrations in hookworm control to the development of a county health organization; the introduction of a public health nursing service;[2]

[1] For details, see The Results of Hookworm Disease Prophylaxis in Brazil, by Wilson G. Smillie. *The American Journal of Hygiene*, January, 1922, v. 2, No. 1, pp. 91–94. Same reprinted.

[2] See page 59.

field experiments in the fight against malaria; and the development of a school of public health.[1] An arrangement has been entered into—the state, the county, and the Board providing the funds—for the first demonstration of county health service in the state of São Paulo.

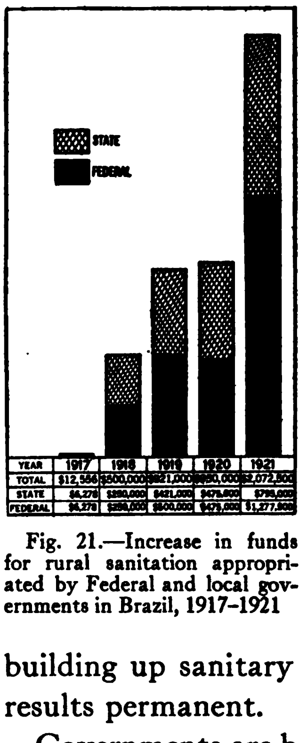


Fig. 21.—Increase in funds for rural sanitation appropriated by Federal and local governments in Brazil, 1917–1921

Progress in Permanent Sanitation in the West Indies

An illuminating field study carried out in Trinidad during the year by Cort and Payne[2] proved to be a striking demonstration of the effectiveness of the measures that are being carried out on a large scale in many lands, and particularly of the soundness of government policy in building up sanitary organizations to make the results permanent.

Governments are becoming increasingly active in Dutch Guiana, British Guiana, Trinidad, Porto Rico, and Jamaica, in providing funds, increasing their sanitary staffs, and in carrying out

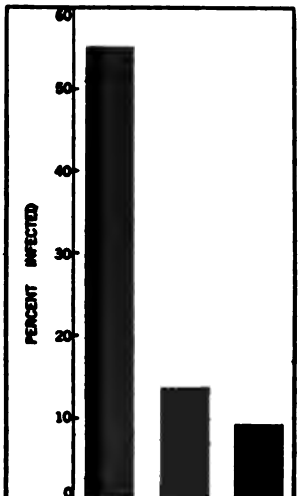
[1] See page 50.
[2] Summarized on pages 81 to 86.

practical operations in the field. For the year 1921 Porto Rico appropriated $800,000 for public health purposes, including a tuberculosis sanatorium; set aside $30,000 of this—in addition to the necessary overhead—for the fight against hookworm disease; and with an efficient field staff under central direction established a creditable standard of soil sanitation in all areas of operation well in advance of the mobile clinics. The present field staff is to be the nucleus of a permanent system of inspection.

Fig. 22.—States of Brazil that have funds available for a program of rural sanitation. Most of the states are receiving Federal aid

In **Trinidad** Government has committed itself to the support of a general scheme of public health; has recently appointed one medical officer of health with provision for a second; has inaugurated a comprehensive plan of malaria control; is providing about $35,000 a year for the maintenance of its sanitary staff; has recently added to it three European inspectors; and has in progress an extensive program of latrine construction. In

Dutch Guiana, where only recently operations were resumed after enforced suspension during the war, Government is giving energetic support; has provided a staff of sanitary inspectors for Lower Surinam and Lower Pará; and with the hearty co-operation of the estates population is effecting a thoroughgoing reform in these regions.



	FIRST SURVEY	SECOND SURVEY	THIRD SURVEY.
EXAMINED	2303	1689	1618
INFECTED	1269	229	149
PERCENT INFECTED	55.1	13.6	9.2

Fig. 23.—Reduction of hookworm infection rate on estates in the Vere area, Jamaica. First survey, November, 1919; second survey, May to October, 1920; third survey, August, 1921. The estate management is continuing systematic treatment and also installing latrines in an effort to stamp out the infection

In **Jamaica** the harassing—and at times apparently hopeless—inertia that early effort in the island had to face has yielded to a popular interest that is becoming increasingly general and aggressive. A striking demonstration in one community shows a fall in infection rate from 55 per cent in 1919 to 13 per cent in 1920, and to 9 per cent in 1921 (see Fig. 23). Areas of operation are now being sanitated in advance of treatment. A conference of parochial boards in December adopted a resolution

approving the appointment of a superintending medical officer for the colony and a whole-time health officer in each of the parishes, with adequate field staff to establish a system of inspection. Government is preparing to expend $100,000 on sanitation during the year 1922.

Developing National Health Organization in Central America

In Central American countries—and particularly in Costa Rica, Nicaragua, and Salvador—measures undertaken in 1914 and 1915 against hookworm disease have passed successfully through the primary stage of field demonstration. Responsibility is being gradually transferred to government authorities, and control of the one disease is being merged into more general schemes of public health. In **Panama**, where development of local initiative has been stifled by the paternalistic policy of the Canal Zone, the formation of a responsible department of health is now being considered. Government is slowly developing a sanitary staff and is providing $12,500 a year for the work of the department of uncinariasis, or hookworm control.

In **Costa Rica** the service was formally taken over on May 28, 1921, as a division under the newly established national department of health,

and the Board's representative was withdrawn. A limited contribution toward its maintenance is being continued through 1922, and provision has been made by means of fellowships for the training of additional men for the posts that are being created. In **Nicaragua** a commission appointed for the purpose by the President has drafted a sanitary code for the country and a law establishing a national department of health to carry it out. The Board is lending the services of a trained scientist to organize and direct a modest diagnostic laboratory, and is providing for the training of a limited number of native doctors for the new government service. The division of uncinariasis is to be the nucleus around which the new department is to be formed.

Salvador has had a national health organization for many years. During the year Government has reconstituted it in the interest of more aggressive action in the field. The new scheme correlates the various government medical services under central control; provides new and adequate quarters; reinforces the staff; creates a public health laboratory; takes over as one of its divisions uncinariasis control; and provides an annual budget of 170,000 colones, in addition to supplying 26,000 colones for the relief and control of hookworm disease and half the funds needed for the fight against yellow

fever. The Board undertakes to aid in the training of additional men.

Promoting Public Health in the Far East

In the Far East the Board is sharing in a wide range of activities representing pretty well all stages of public health development. In **Borneo** the first demonstration in the control of hookworm opened with Government supplying a large part of the funds and the native population giving willing co-operation. In **Fiji**, where operations had been suspended during the war, adequate latrine accommodations were installed over a wide area preparatory to reopening the clinics early in 1922. Government is to assume entire responsibility at the end of three years. The infection survey of **Mauritius**—completed in 1920—led to an arrangement by which the Board is to share on a sliding scale for a period of three years in a series of demonstrations in control measures, leaving Government at the end of that time in full charge. In the meantime aid is being given in the training of local men. In **Madras Presidency, India,** where surveys made between 1915 and 1920 showed a rate of nearly 100 per cent among the laboring population, a scheme of practical operations for the Presidency has been approved, Government supplying all necessary funds save the salary and traveling expenses of

the director. In the face of a sharp economic crisis in **Ceylon** operations are continuing, although on a diminished scale. A proposed revision of the sanitary law is indication of an interest in a more aggressive public health policy for the colony.

In **Siam** the National Red Cross is taking a leading part in the fight against hookworm disease. Government has enlisted the army, the navy, the gendarmerie, and the local chiefs. For more than a year the dispensaries have been treating on the average more than 1,000 persons per week; and an active propaganda has created a demand that the service be made national in scope. Plans are now under consideration for putting the medical school at Bangkok on a modern basis as a necessary first step toward the training of Siamese for public health work.

The five-year scheme entered into with **Australia** in 1918 is now being operated under the new Commonwealth Ministry of Health which was created last year. The services of Dr. W. A. Sawyer, the Board's representative, are being lent to the Ministry for a limited time; Dr. A. J. Lanza has gone out to organize a division of industrial hygiene; Mr. F. F. Longley is to set up a division of sanitary engineering; and Dr. F. F. Russell, of the Board's staff, is to make a brief visit toward the end of 1922 to aid

Fig. 24.—Carrying the gospel of sanitation to the natives of Solomon Islands. Plantation group assembled for lecture on hookworm disease at Rendova

Fig. 25.—Group of Moors assembled at village dispensary to be treated for hookworm disease. After witnessing the results of five years' demonstration work among the Tamil estate population, large numbers of Moors are now voluntarily applying for treatment

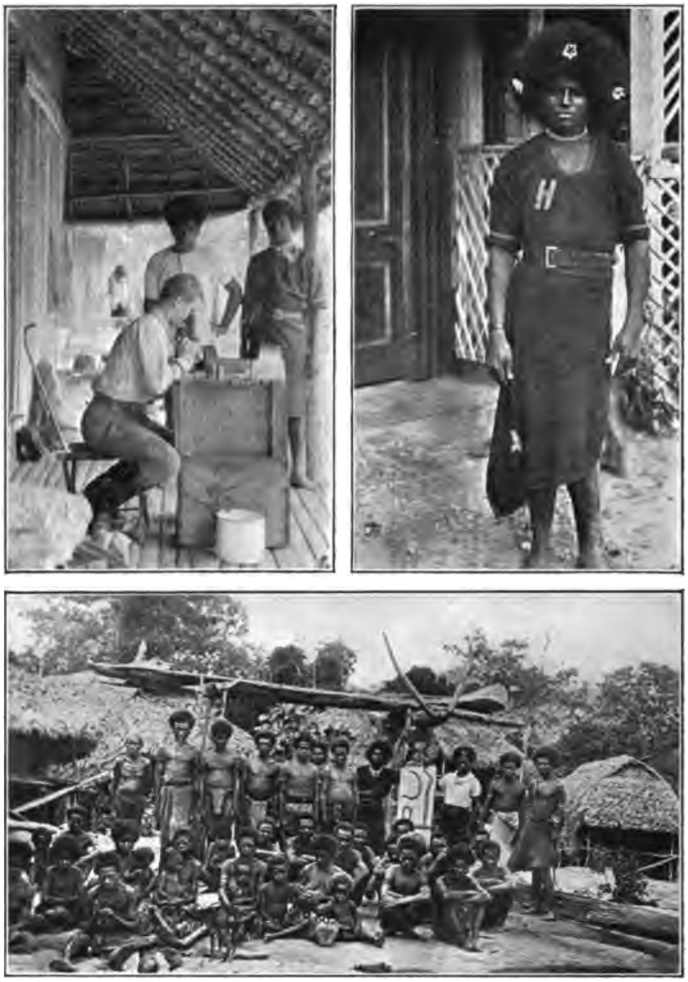


Fig. 26. Three phases of field operations against hookworm disease in Papua. *Upper left:* medical officer examining fecal specimen for hookworm eggs, Yule Island; *upper right:* native assistant in uniform of hookworm campaign staff; *below:* group of natives assembled to hear lecture, Sabuia

in the planning of a system of public health laboratories. In the meantime young Australians are being trained for these positions.

Just at the close of the year comes a call from the **Philippines.** In response to Government request the Board has undertaken to lend the services of Dr. Heiser, Director of its work for the East, for a period of three months; to provide a competent woman to aid in developing a public health nursing service for the Islands; to provide, for two years, a trained director for the public health laboratory in connection with the Bureau of Science; to detail a specialist to carry out a malaria survey; and to provide by means of fellowships for training a limited number of Filipinos in public health.

On Their Own Initiative

The year has brought reports of government and voluntary effort against hookworm disease in which the Board has not shared. Reference has been made in previous reports to the admirable work done in Assam under the direction of Colonel Sir Clayton Lane and to the eminent achievements of Schüffner and his colleagues in Sumatra. Paraguay took up the task two or three years ago; and now the Egyptian government is resuming operations which had been suspended during the war. Dr. Gann, Principal

Medical Officer of British Honduras, has completed a campaign extending over a period of three years and covering systematically the infected areas of the country. The infected have been treated; latrines have been provided, and the people have been taught to use them. It is now proposed to make the results permanent by a system of sanitary inspection. The report from British Honduras forces upon the reader the thought that if government medical officers everywhere had the public health point of view and something of Dr. Gann's aggressive energy, many of the cases of illness that are being treated in expensive hospitals would not occur.

Greater Speed and Economy in Field Operations

Results of the studies by Darling and Smillie in the administration of treatment for hookworm disease, and the more recent resurveys based on worm counts made by Smillie in Brazil, suggest important modifications in field procedures.

The findings of Smillie in Brazil and of Cort and Payne in Trinidad, for example, put beyond further question the value of mass treatment even when considered merely as a prophylactic measure. It is now known that by administering two standard doses of oil of chenopodium as a routine measure about 95 per cent of the parasites harbored by the people of a

community may be expelled. To attempt to get rid of the remaining 5 per cent by following each case to a complete cure would double the cost. By leaving this small fraction of infection—which is not of great clinical importance—to be taken care of by sanitation, it has been found possible greatly to reduce the cost and increase the speed of field operations. A preliminary comparative test in Brazil indicates a saving by this modification of about 50 per cent in per capita cost.[1]

Field Studies in Hookworm Control

Reference has been made above to two or three studies that have been extremely fruitful in practical results. In this field 1921 has been the most productive year in the history of the Board. Colonel Sir Clayton Lane, with a small subvention, has been seeking to improve the technique of stool examination. Beta-naphthol has been given a further test as an anthelmintic on an extensive scale and under field conditions by Mhaskar and Kendrick in India. Ascaridol has been administered on a relatively small scale and with good results by Smillie in Brazil, Mhaskar[2]

[1] For details of working plan suggested by Dr. Smillie see pages 86 and 87 of this report; and Dr. Smillie's article "The Result of Hookworm Disease Prophylaxis in Brazil"; published in *The American Journal of Hygiene*, January, 1922 (v. 2, No. 1, p. 77–95).

[2] Working under the Indian Research Fund.

in India, and Molloy in Nicaragua. The administration of chenopodium without preliminary purge has been further tested under field conditions in Australia, Costa Rica, Panama, Salvador, and Colombia. The practice is becoming general. Dr. Washburn in Jamaica reports continued satisfactory results from the use of compound jalap powder. The most interesting contribution in the field of treatment is by Dr. M. C. Hall[1] of the Department of Agriculture, Washington, D. C., in administering carbon tetrachloride to dogs with 100 per cent efficiency for hookworms. The Willis salt-flotation method of stool examination has been tested on an extensive scale in the field and found to be efficient, rapid, and economical. Molloy of Nicaragua contributed an important improvement. Smillie finds that counting eggs on the slide as a means of estimating severity of infection, while serving as a rough indication when large groups are considered, is of small value in individual cases. Cort developed an improved apparatus for the recovery of hookworm larvae from the soil, and Smillie made an important contribution to the technique of differentiating hookworm and Strongyloides larvae. Dr. Caldwell, in Panama, completed a study of the relation of the action of sea-water on hookworm eggs and

[1] No connection with Board's staff.

larvae to the extremely light infection among the San Blas Indians living by the sea.

A small subvention by the Board made it possible for Dr. Cort, helminthologist in the Hopkins School of Hygiene, to go with a competent staff to Trinidad, British West Indies, for a series of field investigations covering a period of about four months. It proved to be an extremely fruitful expedition. The results, throwing much-needed light on practical control operations, are being published in the form of ten papers appearing serially in the American Journal of Hygiene.[1]

V

Developing Schools of Hygiene

In the autumn of 1913, soon after the beginning of operations on an international scale, the Board faced the fact that in order to carry out the activities it had undertaken it must have a staff of trained hygienists; and that the countries in which it was proposed to encourage public health development must also have such men. The men even for the Board's own staff were not then available. Institutions for their proper training—that is, institutions covering broadly the whole field of hygiene, and equipped to culti-

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[1] For a more detailed summary of the field studies referred to in this section, see appendix, pages 81 to 92.

vate it as a science and to train men in its application as an art—had to be developed. The outcome was a direct contribution to the Johns Hopkins University to establish the Hopkins School of Hygiene and Public Health. The school, now in its fourth year, enrolled during the year 1920–1921, 122 students.

Since 1917 the Board has been contributing toward the development on a very modest scale of an institute of hygiene in connection with the medical school at São Paulo, Brazil. This institute gives an undergraduate course in hygiene to the students in the medical school; conducts short training courses for public health officers; carries out epidemiological field studies for the state; and has done an extremely creditable amount of productive scientific work. During the year the Board pledged about 27,000,000 crowns toward the establishment of an institute of hygiene at Prague. This institute, under the Ministry of Health and in close relation to the University Medical School, is to combine a central public health laboratory for Czechoslovakia with a school of instruction for public health workers. As a result of conferences between the officers of the Board and the authorities of Harvard University and its medical school during the early months of the year, plans were matured and approved by which the Rockefeller Founda-

tion agreed to contribute the sum of $2,160,000 toward the further development of the Harvard School of Public Health. The resources now available are regarded as quite adequate for its immediate needs.

Fellowships in Hygiene and Public Health

In accordance with the policy illustrated in the foregoing section the Board contemplates contributing from time to time, as conditions may favor, toward the development of a limited number of schools of hygiene at strategic points throughout the world. As these institutions develop they will necessarily serve to stimulate and reinforce each other by interchange of experience, facilities, and men. The migration of students in the field of public health will then be feasible on a much more satisfactory scale than is possible under present conditions. In the meantime, however, the Board is taking advantage of the facilities now offered in England, the United States, and, by recent arrangement, in Canada, for the training of students from their own and other lands; and has provided by means of fellowships for a limited number of students to pursue courses in these countries. Fellowships have been granted to students who have been carefully selected with reference to their fitness for important posts as scientists, teachers, or practi-

cal administrators in the public health service, to which in most cases they have had definite assurance of appointment on completion of their courses. These fellowships are regarded as an investment in leadership. For the year 1921 fellowships were provided for fifty-four men and women from thirteen countries, as follows:

Brazil	5	Czechoslovakia	19	Nicaragua	2
Canada	2	France	4	Poland	3
Ceylon	1	Guatemala	1	Salvador	2
Colombia	1	Mexico	1	United States	11
Costa Rica	2				

Extension Courses in Public Health

The well-established schools of hygiene will give short courses for health officers. Under most favorable conditions, however, only a very limited number can be expected to attend these institutions. Each state will find it necessary to provide practical courses for the better training of its own workers. Modest beginnings in this direction are being made in the form of training centers of limited scope, correspondence courses, and institutes. During the year the Board has contributed toward institutes for health officers in Georgia, Ohio, Michigan, and Alabama; toward three institutes for public health nurses in New York state; and toward the organization of a correspondence course to be conducted by the Ohio department of health for full-time county health officers in that state.

Fig. 27.—Counting hookworms expelled by treated patients. Field research conducted under the auspices of the Department of Hygiene of the São Paulo Medical School

Fig. 28.—Group assembled at typhoid exhibit at Prague. One of the earliest activities of the newly organized Ministry of Health of Czechoslovakia, with which the International Health Board is co-operating, was an educational campaign against this disease

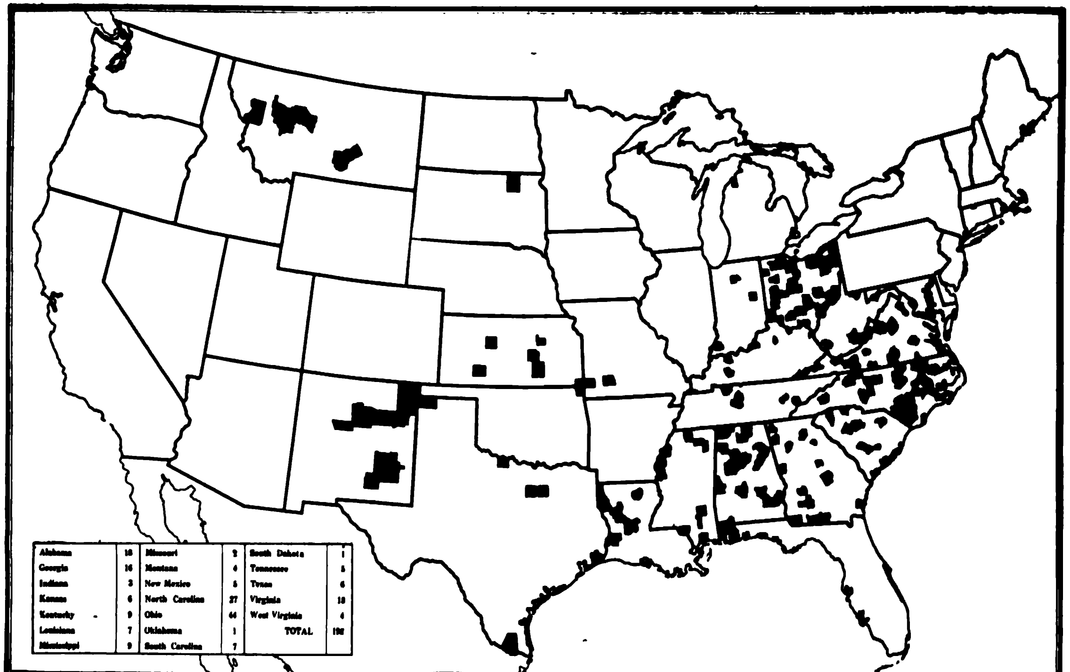


Fig. 29.—Counties having full-time health officers at close of 1921

VI

Promoting County Health Work

For reasons which are well understood public health effort has been centered mainly on the larger towns and cities. Health protection for the people living in country districts has been neglected. The tide is turning. The development of county health organization—which is now going forward with considerable momentum in the United States—is providing a service for the smaller towns and rural communities.

In the Southern States county health administration developed naturally and inevitably from the effort to control hookworm disease. This is a rural disease; its control is a problem in rural sanitation; a serious effort to handle this one problem in rural sanitation called into being county organization. County organization once established, control of hookworm disease became merely an item in a general health program under state and county administration. The demonstration thus given of the value of the county as a unit in the state scheme stimulated a movement which is becoming general. At the close of the year county programs on a full-time basis were in operation in about 192 counties in the United States (see map, page 54).

The Board and the United States Public Health Service are aiding this movement by contributing toward a limited number of demonstrations. The average county health budget is about $10,000, and is provided from state and county funds. When the Board shares in a demonstration, it contributes toward a central budget or from $1,000 to $2,500 toward the county budget. During the year 1921 aid was thus given in sixteen states: Alabama, Florida, Georgia, Kansas, Kentucky, Louisiana, Maryland, Mississippi, Missouri, New Mexico, North Carolina, South Carolina, Tennessee, Texas, Virginia, West Virginia. A similar demonstration is being carried out in Czechoslovakia and in the state of São Paulo, Brazil.

Experiment in County Health Administration

The county program, which is essentially a scheme of rural public health work, is, for the United States, a new undertaking. It invites critical study and experiment. A joint arrangement has been entered into by the Hopkins School of Hygiene, the Maryland State Department of Health, the United States Public Health Service, and the International Health Board by which such an attempt is to be made. The arrangement provides for a full-time service in a county easily accessible to Baltimore and under

the immediate direction of a county health officer reporting to the head of the state service. Washington county has been selected for the purpose and is to contribute to the budget. The county is expected to serve as a field laboratory for the school, and to provide opportunity for investigation and for possible contribution to the development of a sound plan of health activities for rural communities. In so far as the undertaking succeeds it will serve as a demonstration and as a training base for students.

VII

Making Public Health Laboratories More Serviceable

A laboratory service — like vital statistics —is fundamental to intelligent public health administration. The trained health officer, however, understands that the provision of buildings, equipment, and scientifically trained men does not of itself provide the service he needs. Aggressive administration is equally necessary to make these facilities available to the people they are supposed to serve and to educate the doctors and people to use them. Under Dr. F. F. Russell, Director of Public Health Laboratory Service the Board has shared during the year in an increasing number of projects designed to promote this end.

Dr. Russell, while in Europe in connection with plans for the Institute of Hygiene at Prague, made brief visits for his own information to the public health laboratories at the three universities of Austria and some of the principal institutes of hygiene in France—at Nancy, Lyons, Montpellier, and Paris. These laboratories are doing a high order of technical work and are capable of doing a greater amount of it than is being required of them by the physicians of the regions they serve. Assistance was given in Alabama in adapting the state service to the larger opportunities opened up by a new and adequate laboratory building. Arrangement was made for the heads of the laboratory divisions in Alabama and Mississippi to visit the laboratories in other states and to observe the work of institutions where sera and vaccines are produced on a large scale. The state laboratories in Tennessee and West Virginia were visited for consultation regarding possible future developments. During the summer months Dr. Russell visited Panama, Central America, and Mexico. In Nicaragua arrangements were made for a diagnostic laboratory as part of the newly created national health service. In Salvador a national laboratory has been established under the department of health and is being organized by Dr. Segovia, who had been in

training for this purpose on a fellowship granted by the Board. In Guatemala a first step in the direction of a diagnostic laboratory has been made by adding to the equipment and staff of the central laboratory used in the hookworm work. In Mexico Government has plans for a national institute of hygiene. Here the Board has served as agent for Government in finding a suitable American to direct the enterprise for a limited period.

VIII

Establishing a Public Health Nursing Service in Brazil

During the latter part of 1920 the federal health service of Brazil became a national department of health with greatly enlarged powers and resources. The new department, with Dr. Carlos Chagas as its distinguished head, has undertaken among other things a nation-wide program in rural sanitation to be carried out by joint arrangement with the states; and for the Federal District is setting up new divisions for child welfare, venereal disease control, and a crusade against tuberculosis. These activities have made acute the need of trained public-health nurses. To meet the situation Government is establishing a training school in Rio de Janeiro. The Board has undertaken to assist in securing a

competent corps of American nurses to operate the field dispensaries and the training school for a period of three years. In the meantime a selected group of Brazilian women are to be trained with a view to taking over the responsibility. A limited number of dispensaries are in operation and plans have been completed for opening the training school early in the coming year. Arrangements have been made for recruiting the student nurses from the best graduates of the normal schools.

IX

Laying Foundations in Czechoslovakia

The Ministry of Health in Czechoslovakia, confronted with the task of creating a new service for the country, is showing great wisdom in undertaking the training of a staff of selected young men to develop and administer it. In accordance with plans matured in Prague in February, 1920, and approved by the International Health Board the following May, provision was made for a commission representing the Ministry to study public health administration in England and the United States. After the return of the commission early in the year 1921 the Ministry set up a committee to undertake a critical revision of its own plans and procedures. In the

general scheme which is being put into operation first consideration is being given to a few fundamentals: (1) a reporting and statistical service that shall provide the information which the Ministry and local health officers need for their daily guidance; (2) a public health laboratory service that shall make its facilities available to all the people of the country; (3) effective control of the ordinary communicable diseases; (4) provision of wholesome water supplies; (5) protection against contaminated milk; and (6) an institution for the adequate training of personnel. The Board at its meeting in May appropriated approximately 27,000,000 crowns toward the buildings and equipment of an institute of public health at Prague; and provided by means of fellowships for the training of twenty-two young Czechoslovaks for staff positions in this institute and for the administrative services outlined above.

Publications

During the year 1921 the following reports and publications were issued by the International Health Board:

Annual Report for the Year 1920.

Infant Mortality in New York City. By Ernst Christopher Meyer, Ph.D.

Staff members and others directly associated with projects in which the Board participated

made the following contributions to medical and public health literature, most of them in the form of articles published in medical journals that are widely circulated among persons interested in medical and public health topics:

Bass, C. C.

Diagnosis of the commoner intestinal parasitic infections. *Southern Medical Journal*, Nov., 1921, v. 14, p. 863–865.

Standard treatment for malaria. *Public Health Reports*, July 1, 1921, v. 36, p. 1502–1504.

The standard treatment for malaria—a discussion of some of its advantages. *Southern Medical Journal*, Apr., 1921, v. 14, p. 280–288.

Connor, M. E.

Fish as mosquito destroyers; an account of the part they played in the control of yellow fever at Guayaquil, Ecuador. *Natural History*, 1921, v. 21, p. 279–281. Same reprinted.

Cort, W. W.

Investigations on the control of hookworm disease; general introduction. *American Journal of Hygiene*, Sept.–Nov., 1921, v. 1, p. 557–568.

Cort, W. W., D. L. Augustine, and G. C. Payne

Investigation on the activities of infective hookworm larvae in the soil; preliminary report. *Journal of the American Medical Association*, Dec. 24, 1921, v. 77, p. 2035–2036.

Darling, S. T.

The tertian characters of quotidian aestivo-autumnal fever. *American Journal of Tropical Medicine*, Nov., 1921, v. 1, p. 397–408.

Darling, S. T. and W. G. Smillie

Studies on hookworm infection in Brazil; first paper. N. Y., Rockefeller Institute for Medical Research, 1921. (Monograph no. 14.)

Technic of chenopodium administration in hookworm disease. *Journal of the American Medical Association*, Feb. 12, 1921, v. 76, p. 419–420. Same reprinted.

Ferrell, J. A.

Careers in public health service. *Journal of the American Medical Association*, Feb. 19, 1921, v. 76, p. 489–492. Same reprinted.

Measures for increasing the supply of competent health officers. *Journal of the American Medical Association*, Aug. 13, 1921, v. 77, p. 513–516. Same reprinted.

Gregg, Alan

Inspeccão sanitaria da Commissão Rockefeller no estadedoParaná. *Archivos paraenses de Medicina*, Curityba, Jan., 1921, v. 1, p. 273–276.

Inspecçãe sanitaria da Commissão Rockefeller em Santa Catharina. *Archivos paraenses de Medicina*, Curityba, May, 1921, v. 2, p. 11–16.

Guiteras, Juan

Observations on yellow fever in a recent visit to Africa. *Sanidad y Beneficencia*, Habana, Jan.–Mar., 1921, v. 25, p. 34–43.

Hackett, L. W.

Os cinco annos da Commissão Rockefeller no Brasil. *Boletim da Academia Nacional de Medicina*, Rio de Janeiro, 1921, v. 93, p. 62–73.

Harrison, A. P.

Oil field sanitation. *Texas Municipalities*, Sept.–Nov., 1921, v. 8, p. 108–111.

Hegner, R. W. and G. C. Payne

Surveys of the intestinal protozoa of man in health and disease. *Scientific Monthly*, Jan., 1921, p. 47–52. Same reprinted.

Lambert, S. M.

Intestinal parasites in North Queensland. *Medical Journal of Australia*, Apr. 23, 1921, p. 332–335. Same reprinted.

LePrince, J. A.

Co-operative anti-malaria campaigns in the United States in 1920. *Southern Medical Journal*, Apr., 1921, v. 14, p. 297–306.

Noguchi, Hideyo

Prophylaxis and serum therapy of yellow fever. *Journal of the American Medical Association*, July 16, 1921, v. 77, p. 181–185.

Recent experimental studies on yellow fever. *American Journal of Hygiene*, Jan., 1921, v. 1, p. 118–129. Same reprinted.

Noguchi, Hideyo and I. J. Kligler

Experimental studies on yellow fever in northern Peru. *Journal of Experimental Medicine*, Feb. 1, 1921, v. 33, p. 239–252. Same reprinted.

Immunology of the Peruvian strains of *Leptospira icteroides*. *Journal of Experimental Medicine*, Feb. 1, 1921, v. 33, p. 253–260. Same reprinted.

Noguchi, Hideyo and Wenceslao Pareja

Prophylactic inoculation against yellow fever. *Journal of the American Medical Association*, Jan. 8, 1921, v. 76, p. 96–99.

Sawyer, W. A.

Hookworm in Australia. *Medical Journal of Australia*, Feb. 19, 1921, p. 148–150. Same reprinted.

Team work in sanitation. *Medical Journal of Australia*, Apr. 9, 1921, p. 285–287. Same reprinted.

Sedgwick, W. T.
Modern medicine and the public health. *Public Health Reports*, Jan. 28, 1921, v. 36, p. 109–116.

Smillie, W. G.
Comparison of the number of hookworm ova in the stool with the actual number of hookworms harbored in the individual. *American Journal of Tropical Medicine*, Nov., 1921, v. 1, p. 389–395.

Souza, G. H. de Paula
Sanitary propaganda in Brazil. *Bulletin of the Pan American Union*, Apr., 1921, v. 52, p. 364–366.

Stuart, Edward
Popular health instruction. *International Journal of Public Health*, Mar.–Apr., 1921, v. 2, p. 152–163.

Van Dine, D. L.
The destruction of anopheles in screened dwellings. *Southern Medical Journal*, Apr., 1921, v. 14, p. 289–296.

Vincent, G. E.
Passing of the country doctor. *Forum*, Oct., 1921. Reprinted with the title, Modern tendencies in medical education and practice.
World health and the Rockefeller Foundation. *Nation's Health*, May, 1921, v. 3, p. 270–272.

Warren, A. J.
General outline of a comprehensive plan of rural health work. *Kansas State Board of Health, Bulletin*, May, 1921, v. 17, p. 84–87.

Williams, L. R.
Some problems of nursing education. *New York State Department of Health, Health News*, Sept., 1921, v. 16, p. 189–197.

Willis, H. H.
Simple levitation method for the detection of hookworm ova. *Medical Journal of Australia*, Oct. 29, 1921, p. 375–376. Same reprinted.

Wyatt, B. L.
Review of the work of the medical bureau of the Commission for Prevention of Tuberculosis in France, July 9, 1917—Dec. 30, 1920. Paris, 1921.

APPENDIX

ACKNOWLEDGMENT

Extensive use has been made of the following special articles and reports in compiling the appendix, particularly the sections dealing with hookworm disease and malaria:

"Investigations on the control of hookworm disease," by W. W. Cort, D. L. Augustine, J. E. Ackert, F. K. Payne, and G. C. Payne. *The American Journal of Hygiene*, Baltimore, September–November, 1921, v. 1, Nos. 5 and 6; January, 1922, v. 2, No. 1; March, 1922, v. 2, No. 2.

"Anti-Hookworm Campaigns in Southern India," by J. F. Caius, K. S. Mhaskar, and J. F. Kendrick. In manuscript.

"Report Covering Experiments in Malaria Control," by C. C. Bass. In manuscript.

In certain instances the authors' own words have been used. The Board is indebted to these as well as to many other members of the staff for contributions in the form of reports and articles which have made possible the following statement of findings and results.

APPENDIX

I

EXTENT AND SEVERITY OF HOOKWORM DISEASE

INVESTIGATIONS IN INDIA

Early in 1915 the Indian Research Fund Association decided to devote a share of its attention to the subject of hookworm infection in India. Its first inquiry, under the auspices of Colonel Sir Clayton Lane, was carried out in the tea gardens of the Darjeeling district during the winter months of 1915 and 1916. Later, or from October, 1916, to March, 1917, a similar inquiry was conducted among the coolies collected at the emigration depot at Negapatam. In April, 1917, the locale of the investigation was transferred to Dindigul (see map, page 68), and additional work was undertaken in Trichinopoly jail. The work in Dindigul was closed on May 24, 1919, and the staff moved to Trichinopoly, where, until December, 1921, they continued to devote themselves exclusively to investigations into the prevalence and severity of hookworm infection and the factors necessary for its control.

Inauguration of Control Operations. The early investigations having satisfied the authorities of Madras that the infection brought about much physical suffering and economic loss within the Presidency, Government determined to carry out an active campaign against the disease. Upon invitation the Board lent medical officers, in the beginning Dr. George P. Paul and later Dr. John F. Kendrick, to assist in the work, and on April 7, 1920, control operations were undertaken at the Cannanore jail. This piece of work was completed on June 26, 1920, and the following month examination and treatment were begun among the labor forces on the Wynaad-Nilgiri tea estates. Effort continued here until November 15, 1920, when control measures were inaugurated among the employes of the Buckingham and Carnatic mills in the city of Madras. In June, 1921, the staffs of Madras and Trichinopoly joined hands and carried out two experimental campaigns among coolies of the Mudis and Kalyanapandal tea estates in the Coimbatore district.

Prevalence of Infection in Madras Presidency. From the inception of the work in Negapatam in 1916 until the close of the year 1921, a total of 19,239 persons were examined: 16,743 in villages, towns, and rural areas, and on estates; and 2,496 in the city of Madras. In the areas exclusive of Madras city, 97.1 per cent of all persons exam-

ined were found to harbor hookworms; in Madras city, 63.6 per cent. Conditions extremely suitable for the development of the parasites and the spread of the disease were encountered practically everywhere: the country is tropical, and the vast majority of its inhabitants go barefoot, live away from sewerage, and work in the soil.

Severity of Infection in Madras Presidency. Although the investigations indicated that nearly everyone in the Presidency was infected, all classes and all walks of life were not infected to the same degree. Sweepers, or town scavengers, and ryots working in close contact with the soil were found to harbor six times as many worms as the police, and

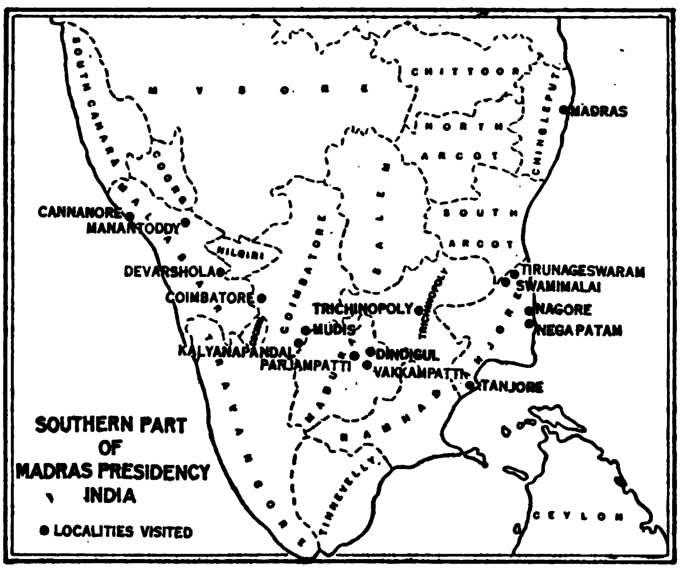


Fig. 30.—Localities visited in investigation into the incidence and effects of hookworm disease in Madras Presidency, India

twelve times as many as the classes who spend most of their time indoors. Among most classes the infection seldom produces severe symptoms, as the parasites are relatively few in number and nearly always the less harmful Necators. It is chiefly to estate laborers that the infection brings an appreciable diminution in health and energy. Since, however, the laboring classes, which are most severely infected, make up the bulk of the population, the country must suffer in the aggregate an enormous economic loss from the effects of the disease.

The following paragraphs give a brief résumé of the findings in the different localities investigated:

a. Inquiry at Negapatam. Of the total of 8,969 persons examined in the investigations conducted at Negapatam, 98.6 per cent of the coolies in the emigration depot were found infected and 91.0 per cent of the people in the town. Since the coolies examined were drawn from thirteen districts and four states of the Madras Presidency, and since the infection was found as often among those who had never before left the country as among those who were emigrating for the second or third time, the results demonstrated hookworm disease to be endemic in India. They suggested also that the infection was universally prevalent in rural areas of the Trichinopoly, Tanjore, Malabar, Madura, and South Arcot districts (see map, Fig. 30, page 68).

The infection occurred in all classes of people examined, irrespective of locality, caste, age, sex, or occupation, yet it was noted that ova were found more readily in specimens from the depot and village population than in those from residents of the town. Sixty-two per cent of the coolies examined at the depot, practically all of whom harbored hookworms but who nevertheless constituted a selected group, were in apparent good health and an additional 35 per cent in fair health. Not more than 3 per cent were visibly affected. Among the children of the town, however, the presence of hookworm infection was unquestionably responsible for much ill health, anemia, and retardation of physical development.

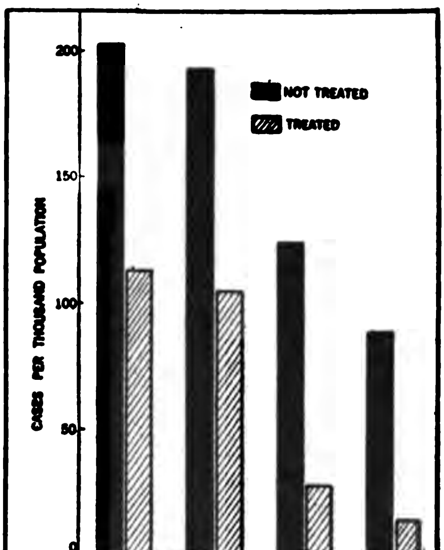
b. Swamimalai-Tirunageswaram. These two typical villages in the Tanjore district were selected for investigation in the hope of gaining some insight into the incidence of the infection among the village population of India. All of the 239 persons examined in the two towns were found infected, irrespective of sex, age, or apparent state of health. The physical condition of the coolie population as a whole was poorer than that at Negapatam. Again the school children showed marked debility and general retardation.

c. Dindigul. Dindigul town and the few neighboring villages were next chosen for observation. Of 412 persons microscopically examined, including sweepers, police constables, factory hands, school children, and patients in hospital, 100 per cent were found infected. Seventy-nine sweepers harbored an average of 127 worms per case; fifty-two police, an average of twenty-one; twenty-one persons of the upper and middle classes, an average of eleven. On the whole the infection was light; in the main the worms were of the species Necator.

d. Vakkampatti-Panjampatti. Examination of 250 fecal specimens in these two villages, located five miles from Dindigul, again showed 100 per cent infection of a degree that, though still mild, was decidedly heavier than in the town.

e. Trichinopoly jail. Of convicts who had resided in the southern part of Madras Presidency, ninety-seven of every 100 examined were found infected. The severity of the infection varied widely according to districts, the average number of worms harbored ranging from 6.2 to 102.8. For ten selected districts the average complement of worms harbored was sixty-two. Here again the worms were mainly of the species Necator.

No clear relationship was discovered between the hemoglobin index and the number of hookworms harbored, and no justification for classification into light, mild, and severe cases on the basis of degree of anemia. Treatment which resulted in complete elimination of the parasites raised the hemoglobin index only two-tenths of a point, or from an average of 74.6 to 74.8. It was, however, shown fairly conclusively that freedom from hookworm disease diminished the susceptibility to bowel complaints and influenza, shortened the period of illness from these diseases, and lowered the death rate (see Fig. 31). There was, moreover, in the matter of gain in weight, a slight difference in favor of treated cases, 72.2 per cent of them showing a gain as compared with 66.3 per cent of untreated cases.



AVERAGE POPULATION	550	553	724	654	522	682	462	936
TOTAL CASES	112	64	140	69	65	19	40	13
TOTAL DEATHS	10	5	8	0	1	0	0	0
AVERAGE DURATION OF ILLNESS (DAYS)	14.1	15.6	15.1	10.7	14.2	9.2	14.8	9.4
YEAR	1918		1919		1920		1921	

Fig. 31.—Incidence of bowel complaints, Trichinopoly jail, India, 1918 to 1921, inclusive. Among prisoners who had *not* been treated for hookworm disease, sickness and deaths from bowel complaints were much more frequent than among those who had been treated

Study of the records for 1,878 prisoners brought out the interesting fact that while the *incidence* of hookworm infection is not appreciably affected by jail life even under sanitary conditions, a natural progressive elimination of worms takes place that does very markedly affect the *intensity* of the disease. Thus, an average infection of fifty-eight worms on admission fell to forty-eight among inmates of a month and to thirty-two, twenty-nine, and seventeen worms, respectively, among inmates of three, twelve, and eighteen months. After eighteen months the average number of hookworms per case, though low, remained nevertheless fairly constant, even so long a stay as seventeen years failing to bring elimination of all the worms.

f. Coimbatore jail. During an interval in the work in Trichinopoly jail brought about by an epidemic of cholera, the stools of 463 prisoners in the Coimbatore jail were examined for hookworm ova and the hemoglobin indices determined in 300 cases. The rate of hookworm infection was 87.5 per cent; the average hemoglobin index, 72.4. The few figures collected showed again that a prolonged stay under the sanitary regimen of jail life brought down the intensity of hookworm infection but in no case eliminated it. There was no opportunity, however, as at Trichinopoly, for investigating the effect of treatment in improving the physical condition of the convicts.

g. Cannanore jail. Microscopic examination of the 964 inmates of Cannanore jail, drawn mostly from the wet districts of Malabar and South Canara, revealed a rate of infection of 89.7 per cent. The incidence among new arrivals is probably nearer 99 per cent, for examination of 197 specimens obtained from persons lately admitted to the jail showed ova in 196, or 99.5 per cent. Only a few cases presented clinical manifestations of severe or even moderately severe hookworm infection. The large number of infected convicts were freed of their worms in a short time by a small staff administering systematic treatment.

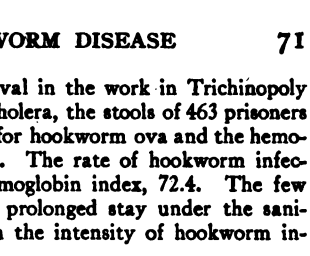


Fig. 32.—Worms harbored by 1,878 prisoners examined in Trichinopoly jail, India, grouped according to length of stay in jail. Natural progressive elimination of worms takes place as the period of jail residence lengthens, the opportunities for acquiring additional heavy infection being limited

h. Manantoddy-Devarshola. On these estates examination of about 2,300 coolies gathered from diverse parts of the Presidency showed 100 per cent hookworm infection among coolies from wet districts and 83 per cent among those from dry. Hemoglobin estimations made on 200 of the coolies revealed an index of 60.0. Most of these estate coolies were in pitiful physical condition.

i. City of Madras. Among 1,782 persons examined at the Carnatic mills in the city of Madras, the general rate of infection was 64.5 per cent. Among clerical workers it was only 18.4 per cent. Of 609 persons examined at the joint school of the Buckingham and Carnatic Mills, the teachers, who wear shoes, were 15.8 per cent infected, and the pupils, who go barefoot, 55.7. In the Chingleput town reformatory 88.6 per cent of the 245 persons examined were found infected.

Signs of severe hookworm disease were seldom seen at the mills; only seventeen cases of profound anemia were observed, and these improved rapidly under treatment. Sanitary latrines, provided in sufficient numbers and in convenient places at the mills, are unquestionably a factor in keeping down the infection. Elsewhere in the city of Madras gross soil pollution occurs, especially around the huts and tenements. In a section of the city containing several hundred one-room tenements, inspection disclosed only one latrine.

j. Mudis tea estates. On this group of five tea estates, located seventy miles south of Coimbatore, microscopic examination of 794 coolies, for the most part recruited from the plains of Madras Presidency, revealed 91.6 per cent infected; examination by treatment and recovery of worms revealed 100 per cent infected. The number of worms harbored by seventy-four coolies whose worms were saved after treatment ranged by provinces from 21.5 to 205.7 per person, an average of 92.9 (see Fig. 35, page 76). Hemoglobin estimates on 1,558 coolies revealed an average index of 74.8, with 10 per cent of the cases lower than 50. Here again no correlation was found between the hemoglobin index and the number of hookworms harbored.

INCIDENCE IN AUSTRALIAN TERRITORY

By the end of the year 1921 all of the projects contemplated in the original plan for the control of hookworm disease in Australia, embracing surveys or control operations in every Australian state and in the three territories, were under way. Surveys were completed during 1920 or 1921 in Tasmania, in New South Wales, in Victoria, in the British Solomon Islands adjacent to Papua, and in additional areas in the state of Queensland. Results to date indicate that Western Australia as well as an area in Northern Territory centering in Darwin is entirely free of hookworm infection.

Victoria and Tasmania. In the survey of the state of Victoria no hookworms were found among the 1,629 persons examined. The mines were as free of infection as the surface, where climatic conditions, particularly lack of rain, are unfavorable to the development of larvae. In Tasmania 2,209 fecal examinations revealed only two cases of hookworm infection, both in persons who had arrived from Fiji during the preceding seven months. The general climatic conditions of this state also are considered unfavorable to the development of hookworm larvae.

State of Queensland. During the year 1921 surveys were completed in nine areas, including the Cloncurry-Hughenden, Longreach-Emerald, and Charleville-Dalby districts, which cover about 500,000 square miles and embrace most of the interior of Queensland.

Examination of 2,120 persons in the **Cloncurry-Hughenden** area showed only fourteen, or 0.66 per cent, infected, and all of these fourteen had received their infection in other regions. The conditions here with respect to rainfall are particularly unfavorable for the development and

Fig. 33.—Ancient temples in Siam put at service of hookworm commission as headquarters for meetings and distribution of literature. Educational activities are an essential feature of the world-wide crusade against hookworm disease

Fig. 34.—Groups of natives assembled for treatment, Tupile, Panama. Hookworm campaigns afford an excellent means of instructing primitive peoples in the rudiments of sanitation

spread of the disease. In fact, the whole area would seem to be definitely non-infectible.

In the **Longreach-Emerald** area examination of 759 children at selected state schools revealed nine cases of hookworm disease, or a percentage of 1.2. The low rainfall, producing dry soil conditions which interfere with the development of the larvae, and the large tracts of land held for pasture, with only an insignificant acreage under cultivation, are believed to be responsible for the low incidence. The survey demonstrated that the disease is almost certainly absent from the surface; the coal mines near Clermont, however, were not investigated.

In the **Charleville-Dalby** area 535 school children were examined and none were found infected. Here again low rainfall was chiefly responsible for the absence of indigenous hookworm disease.

Investigations were also carried out in a small area of fifty-nine square miles centering in the city of Rockhampton, Queensland. In this survey 4,931 persons were examined and only 1.03 per cent found to be infected—a rate too low to call for control operations. The low incidence in the Rockhampton district is explained by the fact that the city has an effective system of night soil disposal, while the district as a whole has little rainfall and but a small proportion of its total area under cultivation. The natives of Hammond Island, near Thursday Island, were examined and found, owing to their habit of living on the beach, to be entirely free of hookworm infection. In an area including Brisbane and vicinity the rate of infection recorded was only 1.4 per cent, and worm counts revealed the average severity also to be low. Only one small region in the state of Queensland remains to be visited by the survey staff—an area with a small population located at the southern end of the gulf of Carpentaria.

Papua. The territory of Papua, surveyed in 1917 by Dr. J. H. Waite, was again surveyed in 1920 by Dr. S. M. Lambert. The investigation, covering the seven months from May 14 to December 15, disclosed a high rate of hookworm infection as far as the survey staff was able to penetrate the country.

The total population of the 821 villages under government control is estimated at 50,000 and in addition there are 7,000 indentured laborers in the colony. The entire population, with the exception of a few whites, consists of native Papuans. The staff examined 6,141 indentured and 633 casual laborers on sixty plantations; 10,372 natives in 166 villages; and 759 natives in nine mission schools. On the plantations the rate of infection was 65.8; in the villages, 54.9; at the mission schools, 59.7. Among the ninety-two white residents examined, only 17 per cent infection was recorded.

There was little difference in the rate or the severity of infection between the villages and the plantations: the average village rate of infection was only 11 points lower than the average plantation rate. Grouped geographically the plantation rates ranged from 62.2 to 84.5 per cent, being highest in the Delta division, where rainfall and temperature are high and there is gross soil pollution. The village rates ranged

from 33.5 to 79.7 per cent. Marked contrast existed between the infection rates of villages in the dry and wet regions, the average being 13.1 for the dry and 70.9 for the wet.

Hemoglobin estimates on 2,891 infected and 835 non-infected natives showed the average index of the infected group to be 55.7 as compared with 63.5 for the non-infected. The low hemoglobin index of the non-infected group is believed to be due in the main to malaria, a disease with which practically all Papuans are infected. Clinical hookworm disease existed in only 5 to 10 per cent of the natives examined. Estate managers report that marked benefits in health and strength have resulted from the course of treatment administered as a feature of the survey.

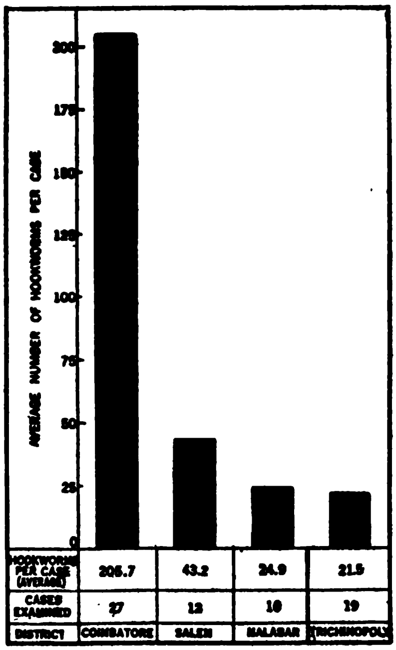


Fig. 35.—Average number of worms harbored by seventy-four coolies at work on the Mudis tea estates, Madras Presidency, India, grouped according to the coolies' districts of origin. Those from Coimbatore were almost entirely of the uncleanly Panchama class

INVESTIGATION IN CHANGWAT LAMPANG, SIAM

Under the new plan of organization adopted for Siam, survey units, operating from strategic centers, are starting out to cover the country in an effort to ascertain the prevalence and severity of hookworm infection and to assist the local authorities in developing among the people a sanitary sense. One such survey—that in the changwat Lampang, mondhol Maharat—was in progress from June 7 to September 9, 1921. Estimates based on the results of the survey indicate that approximately 200,000 of the 275,000 people living in the changwat harbor hookworms.

Examination of 4,038 persons revealed an infection rate of 75.0 per cent; in the four aumphurs in which examinations were made, the rates were 74, 71, 70, and 85 per cent. Among the general population the infection rate was 74.9; among school children 71.7; among

prisoners 73.9; among gendarmes 78.3; and among soldiers 78.2 per cent.

The infection was of a moderate degree of severity. From 355 cases whose stools were saved for seven hours after treatment, a total of 8,181 hookworms were obtained, or an average of twenty-three worms per case. The largest number of worms expelled by any one person was 251. Hemoglobin determinations made on 503 school children gave, it is true, a low average index—74.5—but this was due to various contributing causes, including, in addition to hookworm, malaria and malnutrition.

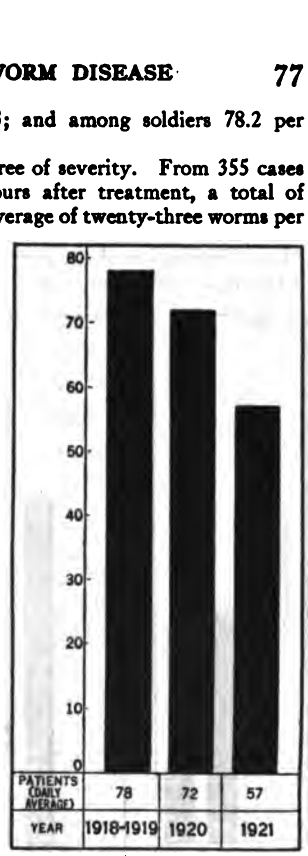


Fig. 36.—Average daily number of patients in Lionel Town hospital, Vere area, Jamaica, 1918–1921, inclusive. Following the anti-hookworm campaign in this area in 1920 there was a significant reduction in hospital cases

CONTROL EFFORT IN BRITISH HONDURAS

An infection survey carried out in British Honduras from February 7 to May 24, 1916, under the direction of Dr. L. W. Hackett, who was lent for the purpose by the Board, awakened considerable interest among the people, and on September 15, 1917, systematic examination and treatment were begun. Through courtesy of Government the Board has received a copy of the report of the campaign, prepared by Thomas Gann, the medical officer in charge, showing results accomplished up to May, 1921.

Approximately 15,000 of the colony's total population of 40,458 live in localities where the infection is so low as not to necessitate treatment. Of the remaining population, practically four-fifths have been reached by the treatment staff. Resurveys made during 1920 of districts whose inhabitants were treated two or more years previously, show substantial reduction in the incidence of infection.

The excellent results accomplished toward stamping out the disease are due in no small degree to the stress that has been laid on soil sanitation. From the beginning police and health authorities have insisted upon the provision of suitable latrine accommodation, until it may be said that at present nearly every place in the colony is provided with adequate sanitary latrines. The exceptions are certain remote

Carib and Indian villages, some small settlements of a few houses each, and lumber and other camps composed, usually, of only temporary habitations.

SURVEYS IN MISCELLANEOUS AREAS

Upon resumption of the campaign in **Dutch Guiana**, investigation in the area selected for initial control operations showed 92.2 per cent infection. A complement of from 300 to 400 worms was not unusual; two persons after a single treatment expelled more than 1,300 worms. From the republic of **Colombia** high rates of infection continue to be reported, the average for the areas embraced within the control program of the year being 92 per cent. In Quebradillas, the first area to be worked under the new plan of control approved for **Porto Rico**, an infection rate of 86.2 per cent was recorded among the 7,107 persons examined. Many severe cases were noted, though worm counts and hemoglobin estimations do not reveal a very severe general infection. In **Jamaica** an average infection rate of 39 per cent is reported for the districts worked during the years 1920 and 1921. In this colony a striking difference is reported in the infection rates for wet and dry districts, the average being 85 per cent for the former and only 10 per cent for the latter. The infection rate for the British Solomon Islands, just surveyed, is reported as 24.7.

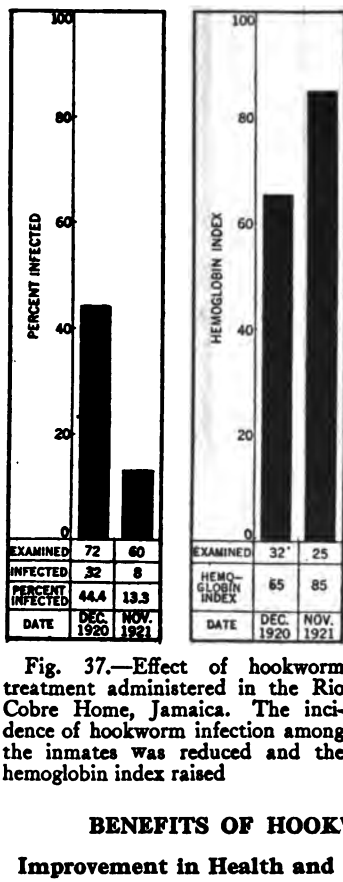


Fig. 37.—Effect of hookworm treatment administered in the Rio Cobre Home, Jamaica. The incidence of hookworm infection among the inmates was reduced and the hemoglobin index raised

BENEFITS OF HOOKWORM TREATMENT

Improvement in Health and Physical Condition, Jamaica

Statistics for the Lionel Town hospital in Jamaica, an institution which serves the estates and villages of the Vere area, where operations for the control of hookworm disease were carried out between November,

1919, and April, 1920, show that during 1918 and 1919 the average daily number of patients was seventy-eight, and during 1920, seventy-two. In 1921, following a campaign against hookworm disease in the area, it dropped to fifty-seven—a decrease in one year of 20.8 per cent (see Fig. 36, page 77). Before 1920 more than 80 per cent of the patients admitted to the hospital were infected with hookworm disease, as compared with not more than 5 per cent during 1921.

At another institution in Jamaica, the Rio Cobre Home, thirty-two children out of the seventy-two examined in December, 1920, had hookworm disease; in November, 1921, following a campaign against the disease in which all infected children received treatment, only eleven out of sixty examined were found to be infected. Meanwhile the average hemoglobin of all children in the institution had risen from 65 to 85, an increase of 30.8 per cent (see Fig. 37, page 78), and the average weight had increased from 46.5 to 51.6 pounds, or 11.0 per cent. Twenty-five of the children examined in 1921 were among the group of thirty-two who were cured of hookworm disease a year before, and eight of them were found to have been re-infected—a re-infection rate of 32 per cent.

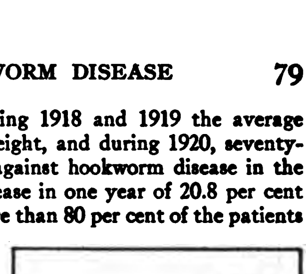


Fig. 38.—Hemoglobin indices of 18,514 persons in Costa Rica. Compare index of the group not infected with hookworm disease with that of the infected persons before treatment as well as after cure. In this country increased appetite, blood regeneration, and improved health promptly followed treatment for hookworm disease

Increased Efficiency of Sumatran Laborers

Recent official government correspondence from Mauritius calls attention to the fact that by means of control measures in Sumatra during the period from 1906 to 1918 the proportion of first-class coolies (those not infected, or only lightly infected, with hookworms) rose from 35 to 90 per cent, while that of moderately infected coolies fell from 50 to 10 and that of severely infected from 15 to 0.5 per cent. The number of badly infected coolies on insanitary estates in this colony averaged ten; on sanitary estates, three. The sanitary estates showed 1.8 per cent of coolies sick; the insanitary, 3 per cent.

Three estates in Sumatra which, in spite of all recommendations,

refused to adopt hookworm control measures, had in the course of two and one half years 4,657 admissions to hospital. Three other estates with a laboring force of the same size which did adopt these measures had only 1,034 admissions—a difference of 78 per cent. One hospital admission represented on the average twenty-two days of treatment, which, reckoned at fifty cents a day, meant an aggregate loss of no less than 40,000 guilders during a period of only two and one half years.

II

LIFE OF HOOKWORM EGGS AND LARVAE IN THE SOIL

The department of medical zoology of the School of Hygiene and Public Health of the Johns Hopkins University dispatched to the island of Trinidad, British West Indies, during the summer of 1921, an expedition to study the life of hookworm eggs and larvae in the soil. The expedition was under the direction of Dr. William W. Cort of Johns Hopkins University and was aided by a subvention from the Board. Those who took part in the investigation included Dr. James E. Ackert of the Kansas State Agricultural College, Mr. Donald L. Augustine of Johns Hopkins University, Dr. George C. Payne, the Board's director in Trinidad, and his wife, Dr. Florence King Payne. The party from the United States sailed from New York May 5 and returned September 17. The work was conducted with the active co-operation of the Government ancylostomiasis commission and was carried out at Princes Town, in the south central part of the island in an area where sugar-cane cultivation predominates and over 70 per cent of the people are hookworm infected.

Finding of Unsheathed Hookworm Larvae in the Soil. Although various investigators have reported that under certain conditions mature hookworm larvae may lose their sheaths while still living in the soil, the general opinion has prevailed that they normally pass this period of their existence enclosed in sheaths and complete their second larval molt only when penetrating the human skin. Both field and laboratory studies in Trinidad showed, however, that it is a common occurrence for mature hookworm larvae to lose their sheaths while continuing to live in the soil. The loss of sheath, moreover, did not render the larvae non-infective.

Of a total of 4,265 mature larvae isolated from a series of 108 positive soil samples taken from an area of a sugar-cane field heavily polluted by individuals infected with hookworms, only 42 per cent were enclosed within the protective sheath. The finding was further supported by the studies of conditions under which hookworm eggs hatch and develop and of the migration of infective larvae, both of which showed that a proportion of the larvae became unsheathed while in the soil. The discovery will doubtless call for a revision of many former ideas that have resulted from a study of sheathed forms.

Length of Life of Larvae in the Soil. The discovery that so large a proportion of the larvae shed their skins while still living in the soil introduces a new factor for consideration in determining the length of larval life. Under favorable conditions this molting was not found to shorten the life of the larvae, although in unfavorable environments it

did seem to decrease somewhat their chances of survival. Tropical temperature and other environmental conditions which tend to increase the activity of the mature hookworm larvae were found to shorten their lives through the more rapid using-up of the stored food material.

The Trinidad investigations showed that the life of larvae in the soil seldom exceeds six or seven weeks. Heretofore it had been believed that under favorable conditions of temperature and moisture they lived for months or even years. In the cane-field area, where there was intense soil infestation, the number of larvae was reduced more than 90 per cent within three weeks after soil pollution was stopped, only a very few larvae being left at the end of six weeks. Laboratory experiments with different soils under different conditions showed, too, a great reduction in the number of larvae in two or three weeks and an almost complete dying out in six weeks.

Relation of Chickens to Spread of Hookworm Disease. So far as Trinidad at least is concerned the expedition reported that chickens help to limit rather than to spread the disease. The great majority of hookworm eggs ingested by chickens failed to produce infective hookworm larvae after passing through the chickens' alimentary tracts, the failure being attributed in part to the breaking of eggs in the gizzards, to injury from urine in the chicken feces, and to malnutrition of the larvae. Although chickens that have swallowed hookworm eggs day after day may establish dangerous infective spots around drinking receptacles; although they may carry eggs and larvae from places unfavorable for their development and deposit them in favorable environments; and although they may transport to dooryards and other places traversed by barefooted persons human stools voided in out-of-the-way localities, the reduction of mature hookworm larvae brought about by the fowls was nevertheless found to be more than sufficient to offset the establishment of these additional infective spots.

Relation of Pigs to Spread of Hookworm Disease. The discovery of a new species of hookworm (*Necator suillus*) as being of common occurrence in the domestic pigs of Trinidad marked the study of the rôle played by pigs in disseminating the infection. The investigation showed, moreover, that the pig, ranging freely, is an important factor in the spread of hookworm infection. A high percentage of human hookworm eggs ingested by pigs were found to produce infective larvae, the hatching, during the rainy season in Trinidad, usually occurring within five days.

Effect of Hookworm Control Measures. To determine the sources of human infection and to learn the effect of a control campaign on soil pollution, on soil infestation, and on human infection, an intensive epidemiologic study was made of an area in a sugar estate. Of 146 East Indians and negroes living in the area chosen for study, 117, or 82.4 per cent, were found to be infected with hookworms. A series of three treatments greatly decreased the proportion of persons infected as well as the total number of worms harbored.

Fig. 39.—Group assembled to hear lecture and receive treatment for hookworm disease, Fusagasugá, Colombia

Fig. 40.—Exhibit on hookworm disease at the National Agricultural Exposition, Brisbane, Australia

Fig. 41.—Negro family, residents of Federal District, Brazil. All except mother treated in 1919 for hookworm disease. Mother first treated in 1921, expelled 123 hookworms; other members of family, re-treated in 1921, expelled average of six worms

Fig. 42.—Examining board and other apparatus used in Jamaica in examining fecal specimens by the salt-flotation process. Great speed, accuracy, and economy are resulting from this and other improved methods of diagnosis

First inspection showed soil pollution in the area to be widespread and gross, though concentrated at certain easily accessible places in the cane fields near the barracks. Soil samples showed little soil infestation except along the heavily polluted strip of cane. The building of adequate latrines and the carrying on of an educational campaign effected great reduction in pollution in the cane field. A series of soil samples taken at intervals showed a rapid dying out of infective hookworm larvae, so that in about six weeks soil infestation was practically eliminated.

Examination of soil samples indicated that even if moisture was present, conditions on the clay loam soil were not favorable for the development of hookworm larvae unless there was considerable protection, especially by vegetation; and an analysis of the habits of the people in relation to the distribution of soil infestation suggested that most of the heavy infection was due to the practice of defecating at selected places in the cane field. The localized character of soil infestation, especially in the cane field, showed that there was little migration of infective larvae, although there was evidence that the larvae could be carried considerable distances by water.

Epidemiologic Study on Cacao Estate. Examination of the people living in three houses on a cacao estate showed a heavy infection with hookworms. As in the case of the sugar estate, pollution of the soil was confined almost entirely to definite spots, "natural latrines," in the cacao grove near the barracks. Here, again, examination of soil samples demonstrated that the larvae did not migrate and that almost all the human infection was derived from visits to the natural latrines. Even in this grossly polluted strip of soil, however, the findings were somewhat irregular, indicating that conditions were not always favorable for the larvae to develop. Six weeks after three routine treatments had been given, soil samples taken from the former heavily polluted spots showed marked reduction of soil infestation.

Migration of Larvae in Soil. Studies of migration showed definitely that hookworm larvae do not move from their original place of development unless carried away by the action of water or on the feet of man or one of the domestic fowls or animals. Larvae placed on moist soils did not migrate in periods of from fifteen hours to forty-two days. Not only did they not migrate even when their environment became unfavorable, but in the course of the experiment there was, through the dying out of the larvae, striking reduction in their numbers, the rate of reduction increasing with the passage of days.

Position of Larvae in the Soil. Infective hookworm larvae under the most favorable conditions of moisture and temperature were found to remain on or near the surface of the soil. They crept up pieces of wood, decaying vegetation, and other objects only as far as a film of moisture extended. They were not found within drops of water collected in the axils of leaves or green plants, nor upon the leaves themselves. At the centers of soil infestation they were found on the leaves or twigs

when the latter were moist. When the leaves or twigs were dry, the larvae retreated to the underlying soil.

GREATER SPEED AND ECONOMY IN FIELD OPERATIONS

The demonstration by Cort and his associates that the life of hookworm larvae in the soil is much shorter than had been commonly supposed; that the larvae do not migrate; and the earlier demonstration by Smillie that hookworms are slowly acquired and slowly lost, find complete confirmation in the results of the 1921 resurveys of Governor's Island and Jacarepagua, Brazil (see pages 33 to 35). Not only do these findings abundantly confirm the fundamental soundness of the working methods that have been employed to effect the control of hookworm disease, but they indicate the lines to be pursued in future efforts to secure greater speed, economy, and efficiency in field operations. With the data now at hand it is possible to formulate a simplified plan of procedure based, not on removing the last hookworm from every infected individual, but on keeping reduced to a point at which they do no serious harm to the individual or to the community, the number of worms harbored. A paper recently published by Dr. Smillie gives the details of a method he has evolved to meet this end.[1]

Plan of Control for Heavily Infected Areas. In communities where almost all the people are soil workers—poor, ignorant, barefoot, spending ten or twelve hours daily in the fields, and subjected to all the factors that tend toward heavy infection—Dr. Smillie recommends a preliminary treatment campaign in which three treatments of a standard remedy would be given to all workers in the soil. Simultaneously the attempt would be made to secure the installation of latrines at not less than three fourths of the houses. After this proportion of the homes had sanitary latrines a second treatment campaign would follow. In the second campaign every positive case would receive only one treatment, and special effort would be made to treat all who work in the soil. Following this, a small staff would be stationed permanently in the community to secure the continued construction and maintenance of latrines, to treat newcomers, and to serve as the basis for a future rural health unit.

Plan for Lightly Infected Areas. In communities whose inhabitants generally are in better circumstances, accustomed to a better mode of living, and less severely infected, he recommends treating twice all positive cases except soil workers, whom he would treat three times, and at the same time inaugurating a campaign of latrine construction. Upon completion of treatment a small staff, who would remain to continue the work of latrine construction and to treat newcomers, would devote certain days of each week to general dispensary work, when they would treat any hookworm infected persons who came to the clinic. Here, again, the small unit would serve as the basis for extending perma-

[1] The Results of Hookworm Disease Prophylaxis in Brazil, by Wilson G. Smillie. *The American Journal of Hygiene*, January, 1922, v. 2, No. 1, pp. 91–94. Same reprinted,

nent rural sanitary activities throughout the community. While hookworm infection would not be eradicated by either of these plans, hookworm disease would be adequately controlled if latrines were constructed and faithfully maintained and used.

Mass Treatment in Absence of Latrine Provision. In communities whose inhabitants suffer with severe hookworm disease and who either cannot or will not build and use latrines, treatment is the only method of attack that can be used. The Brazilian experience shows that an individual who receives two standard treatments and is thus freed of practically all his hookworms, but who reverts to the conditions of living which produced his first infection, does not usually regain a large complement of worms until at least three years have elapsed. Under such circumstances it is therefore safe to follow the plan of giving all individuals a standard treatment once a year.

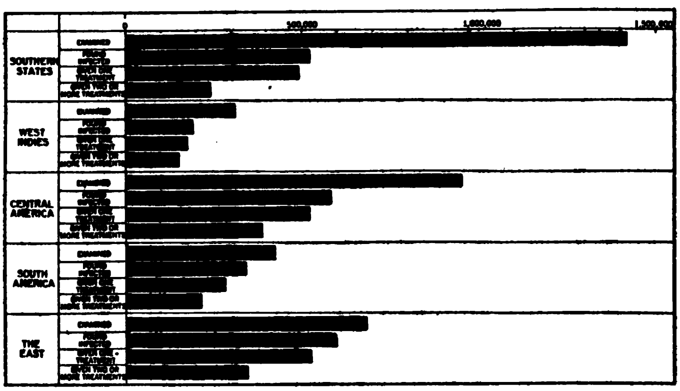


Fig. 43.—Number of persons examined and treated in world-wide campaign against hookworm disease, 1910–1921, inclusive, by main geographical divisions (for details, see Table 1, page 124.)

EFFECT OF SALT ON VIABILITY OF HOOKWORM EGGS AND LARVAE

A limited study of the effect of salt on the viability of hookworm eggs and larvae, carried out during 1921 by Dr. Fred C. Caldwell, director of hookworm control in Panama, showed that for all practical purposes sea water prevents the development of larvae. Particularly favorable conditions for the study were afforded by the habits of the San Blas Indians, who live on 227 islands stretched along 130 miles of coast and have the time-honored, inviolate custom of defecating in the sea. Non-Indian residents, however, frequently pollute the soil. In a number of localities

on three islands having the same climatic conditions, the average rate of infection among 595 Indians examined was only 4.7 per cent, as compared with the rate of 62.9 per cent among thirty-five non-Indian residents.

In the Spanish village of Puerto Obaldia on the San Blas coast, where soil pollution was general, every person examined was found infected. A large proportion of the non-Indian population of all three of the islands had lived for considerable periods in the city of Panama, a fact that is doubtless responsible for the rate of infection being lower among them than it would have been if they had spent their whole lives on the islands. All the infected Indians had either spent extended periods on the mainland or had lived in close association with Jamaicans or Colombians while engaged in the gathering of rubber.

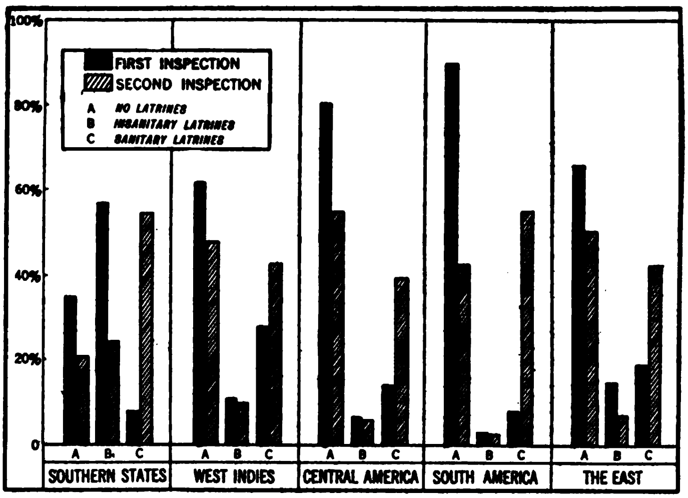


Fig. 44.—Sanitary conditions on first and last inspections compared for the five main geographical divisions of the world-wide campaign against hookworm disease, 1910–1921. In all regions extensive sanitary improvement has gone hand-in-hand with treatment

APPARATUS FOR RECOVERING HOOKWORM LARVAE FROM THE SOIL

The staff engaged in the investigations in Trinidad used with much success, in every phase of their work, a modification of the apparatus invented by Baermann for recovering larvae from the soil. It permitted determination to be made of the exact sources of infection through examination of large numbers of soil samples from various parts of areas in which hookworm disease was prevalent; it enabled the staff to follow

closely the reduction of soil infectivity that resulted from the elimination of soil pollution; and it made possible not only a careful study of the conditions under which the eggs develop, but also of the extent of migration of the larvae, the rate of unsheathing, and the length of larval life in different kinds of soil.

The apparatus consists of a glass funnel almost filled with water and with the outlet closed by a clamped piece of rubber tubing. The soil sample is placed in a sieve so fitted into the funnel that the level of the water is above the lower surface of the soil, thus bringing the soil sample into contact with water of a considerably higher temperature than that of the soil. Under these conditions a large proportion of the nematodes pass from the sample into the water, where they can be collected and counted.

For examining soil samples of half a pint or more, large glass funnels eight inches in diameter, and specially prepared brass sieves seven inches in diameter, three inches deep, and with a one millimeter mesh, were used. To prevent small particles of soil sifting through into the funnels the sieves were lined with one or two thicknesses of cloth. It is possible to substitute for the sieve a piece of wire screen covered with cloth, of such a size that it can be fitted down into the funnel. The sieves have the advantage, however, of being more easily handled in changing samples of soil.

III

DIAGNOSIS OF HOOKWORM DISEASE

WILLIS SALT-FLOTATION TECHNIQUE

The Willis salt-flotation technique of stool examination found added favor in the work of the year. It is proving particularly valuable for detecting light infections usually missed by the less refined plain smear and centrifuge processes. In Salvador, for example, it increased by 10 to 15 per cent the number of specimens found positive with the aid of the centrifuge. In Ceylon 449 additional positives were found in a group of 1,569 specimens—an increase in efficiency of 28.6 per cent.

The process calls for adding to the feces a saturated solution of coarse table salt drop by drop until the container in which the specimen is received is filled to the brim. The mixture is thoroughly stirred and allowed to stand for a few minutes to permit the ova to rise. A clean polished slide is then placed on the container in contact with the surface of the fluid. In a short time the ova adhere to the slide, which is removed and examined with the microscope. The method is so simple, efficient, and economical that it is rapidly coming into use in all countries. Tests in Queensland showed that as compared with the brine flotation method the Willis technique had the advantage of being quicker; of requiring less apparatus, no steel wool and no wire loops being needed; of using less salt solution; and of permitting the discarding of the tins after use and so offering no possibility of ova being carried from one tin to another.

To facilitate examination by the Willis method Dr. Molloy, in Nicaragua, has improvised a special board which has proved effective in field work. The board—the end of a box in which gasoline is shipped—measures 13¾ by 9½ inches, and is covered on one side with a piece of tin to facilitate washing. To this board are nailed, in two rows, the tops of ten containers. The specimen containers are placed in these tops before the salt solution is added. The board is of a convenient size to handle and is easily cleaned.

LANE LEVITATION METHOD

Colonel Sir Clayton Lane, who has been at work for several years seeking to develop a technique of stool examination that will combine the utmost simplicity with the greatest refinement, recommends a levitation process and stresses the advisability of using chemicals to preserve the stools and so permit their examination under more favorable circumstances than are usually found in the field. The fact that levitation may be applied as successfully in preserved as in fresh stools, if certain disin-

fectants are used, offers the hope that it may prove practicable to effect further economy and efficiency by dissociating diagnosis, in time and place, from the other phases of hookworm work.

Dr. Lane finds that the process of levitation when properly carried out collects in a condition of full visibility an average of ten times as many eggs as can be secured by other methods of slide preparation. In Bengal, for instance, he added by levitation about 10 per cent to the infection figures obtained from strained and centrifuged films; and Dr. Mhaskar, testing the results of examination by searching the stools for hookworms after a vermifuge had been given, found that levitation had disclosed 7 per cent more positive cases than had been yielded by ordinary film examination. Dr. Lane is continuing his studies with the aid of a small subvention from the Board, and proposes to establish, by actual counts of eggs in fixed quantities of stool, what proportion of the eggs are lost and what proportion are collected in a condition of full, uncamouflaged visibility, in examinations by the plain smear, the centrifuge, the salt flotation, and the levitation techniques. In each case comparison will be made of the figures for stools treated and stools untreated by chemical preservatives.

ESTIMATING SEVERITY BY COUNTING EGGS IN FECES

Dr. W. G. Smillie conducted in Brazil during 1921 a test in which he sought to ascertain the possibility of estimating the severity of infection by counting the ova in the microscopic field. One hundred thirty-five cases harboring an average of thirty-two worms each, forty of which had been found negative with the microscope, were included in the test. The centrifuge method of examination was used, and the positive cases were classified into five groups in accordance with the number of ova found in the stools. The cases were later treated and all their worms expelled.

So far as general averages were concerned there was a definite relationship between the number of ova in the stools and the number of worms in the intestines, but in individual cases the clue afforded by a single examination of the stool was very unreliable. One individual having very abundant ova harbored only twenty-three hookworms; while others having so few ova that they were found only after long and careful search, harbored from 150 to 200 hookworms.

DIFFERENTIATION OF HOOKWORM AND STRONGYLOID LARVAE

In the routine examination of feces in field laboratories it is difficult to distinguish hookworm from Strongyloid larvae. Dr. Smillie has evolved a simple process for identifying the larvae, based on the marked differentiation that takes place as they mature. The technique results in many specimens being found to contain Strongyloides that are unrecognized by routine microscopic examination.

At the end of the day's work specimens containing the larvae to be identified are prepared in a Petri dish of standard size. In the center of the dish a circle from five to seven centimeters in diameter is drawn with a wax pencil or with cocoa butter. Within this circle are placed from one to two grams of feces and from one to two mils of water. The dishes are covered and allowed to stand at a temperature of from 75° to 90° Fahrenheit. The cultures may be observed on the following morning—fourteen hours after preparation,—and again on the second morning—forty hours after the culture was begun. The top is removed from the Petri dish and an ordinary hand lens is used in searching for larvae in the water surrounding the feces. During the interval of fourteen hours the larvae leave the feces for the surrounding water and swim freely about in large numbers.

The different habits and sizes of the two larvae render identification easy. The Strongyloides occur in two forms: the first as free living adult males and females, which usually appear near the margin of the feces and are of a size to be readily visible to the naked eye; and the second as filariform Strongyloid larvae found at the very periphery of the water, usually with their bodies at a right angle to the circle, and in active, even frantic, motion. Hookworm larvae differ from the free living Strongyloides in that they are many times smaller and are usually found at or near the fecal margins. They are sluggish in motion and thus offer a marked contrast to the active filariform Strongyloid larvae.

IV

MALARIA CONTROL

ANTI-MOSQUITO MEASURES: SOUTHERN STATES

Malaria control by anti-mosquito measures made marked progress in the Southern States during the year. Despite unfavorable financial and climatic conditions a total area of 225 square miles was controlled and a total population of 228,740 persons protected. Through joint co-operation between the town and county authorities, the state boards of health, the United States Public Health Service, and the International Health Board, new demonstrations were conducted in twenty-six towns in the states of Alabama, Arkansas, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, and Texas; and in thirty-five other towns in these states and in Virginia supervision was given to the maintenance of control established in previous years. A considerable number of towns also conducted control measures on their own initiative and without outside assistance, a number of transportation and industrial corporations interested themselves in anti-mosquito activities, and from the towns the work began to spread to rural communities.

Measures Employed. In the work of control, effort centers on the elimination of the breeding places of malaria mosquitoes. The measures employed consist of simple drainage, filling borrow pits and shallow pools, channeling streams; clearing the margins of streams and ponds, removing obstructions, letting in the sunlight, oiling, and enlisting the services of the top minnow (*Gambusia affinis*) to keep down breeding. It is necessary also to protect unscreened or unsatisfactorily screened wells and cisterns and to remove or cover old tin cans and similar artificial containers.

In all towns in which work is conducted preliminary surveys are made to determine whether effective malaria control can be secured at reasonable cost. Whenever possible the surveys are made late in the summer or in the autumn of the year preceding the beginning of control effort. The drainage operations are usually so planned as to be practically completed before the mosquito season opens.

The measures employed, while practically eliminating the malaria mosquito, do not guarantee freedom from the mosquito as a pest. A significant decrease in the numbers of all mosquitoes—Culex as well as Anopheles—results, but it is much more difficult and expensive to obtain freedom from all mosquitoes than from Anopheles alone. To obtain complete mosquito control careful inspection of backyards and surrounding premises is required.

Results and Costs.[1] Figures 11 and 12 (pages 19 and 20) exhibit typical results accomplished. The reduction in malaria on the basis of

[1] All cost figures given in this paragraph exclude the expense of general supervision.

physicians' calls is in the case of some towns as high as 90 per cent. Figures showing the reduction effected are not available for all towns, however, as information concerning malaria incidence is seldom recorded for the years that precede the control program.

Several towns reported that the control operations resulted in malaria being completely eliminated. Physicians were practically unanimous in reporting a marked reduction in the number of their visits for malaria, and pharmacists stated that there had been a noticeable diminution in the demand for chill tonics and similar proprietary "remedies" for malaria.

In the new towns the cost of original installation during 1921 ranged from $225 for the town with the lowest cost to $6,234 for that with the highest, the total for the twenty-six amounting to $67,411. Inasmuch as a total population of 67,063 was protected, distributed in towns varying in size from 268 to 13,088, the cost per capita was $1.01. In the other thirty-five towns the maintenance measures protected a total population of 161,677 at an average cost per capita of only twenty-five cents.

Data submitted by thirteen of the twenty-six installation towns indicate that the average first year's cost of each main feature of the work was as follows: ditching $345 per mile, clearing streams $95 per mile, and oiling $3 per mile. The average cost of maintenance was $16 per mile. Premises were inspected for mosquito breeding at an average cost of six cents. All of these costs, of course, are subject to wide variation depending upon conditions to be met. Nevertheless, it is felt that the averages are fairly representative. In some towns natural conditions made possible control at trifling cost. Thus, in Bullard, Texas, control was secured for only $66.83, of which $11.83 was spent for oil and $55 for the labor of applying it.

The effectiveness of the control program is well illustrated by statistics for the town of Lake Charles, Louisiana. This town, with its population of 13,088, was embraced within the extra-cantonment zone in which anti-mosquito measures were carried out by Government during 1917. For that year the estimated calls for malaria numbered 250. The next year, following the installation of control measures, the calls dropped to eight. Upon the close of the war control effort in the town and vicinity was permitted to lapse, with the result that the cases of malaria rose to 500 for the year 1920. In 1921, following the renewal of control effort in April of that year, the total number of cases was only fifty.

Economic Value of Work. Complete data are not available to show the economic loss that results from malaria, and estimates are in most cases difficult to make. Nevertheless, certain facts and figures collected during 1921 are at hand to indicate the saving in dollars and cents effected by the application of control measures.

Thus, the town of Lake Charles, Louisiana, sustained during the year 1920 losses from malaria estimated at $26,000. During 1921 control measures, which practically stamped out malaria and eliminated this loss, were applied at a cost of only $4,965, representing a saving to the town in its malaria bill of $21,035, or 81 per cent. Again, Mr. George L. Grogan,

Fig. 45.—Ditch along railroad embankment, before and after draining, Demopolis, Alabama. Minor drainage operations constitute the chief feature of anti-mosquito measures as conducted in the Southern States

Fig. 46.—"V"-shaped ditch, a part of the drainage system installed to control malaria in and near La Puebla-Rivas, Nicaragua

Fig. 47.—Anti-malaria, impounding water experiment at Mound, Louisiana. View across bayou, 700 yards above dam site, before clearing

Fig. 48.—Same as Fig. 47, showing bayou filled with water

manager of the Grogan Lumber Company at Gladstell, Texas, states that the installation of control measures during 1921 cost the town a total of $5,036 and protected 500 people. In this instance the first year of control cut the company's malaria bill in half.

Public Appreciation. The work is meeting with high favor in all the states, as is evidenced by the fact that in practically all the towns where it has been begun there is almost no opposition to its continuation.[1] Many of the towns in which demonstrations are made continue the drainage work during the winter months and in the spring have the ditching in good order for early work to prevent mosquito breeding.

The town of Crossett, Arkansas, continued control measures during 1921 for the sixth consecutive year at a cost of $5,349 for the year; the town of Hamburg, Arkansas, completed its fifth, and the towns of Lake Village and Dermott, Arkansas, their fourth, successful year of malaria control (Figs. 11 and 12, pages 19 and 20, exhibit results accomplished). In all these towns the bulk of the citizens heartily endorse the work and there is every indication that it will henceforth be carried on as a regular municipal function.

Consolidation and Extension of Service. The work of the year has been characterized by a growing tendency to center control measures in the county health departments, and to arrange through them not only for the initial installation but for subsequent supervision and maintenance. The state boards of health are also taking active interest in the work, and many of them are securing their own malaria control personnel. During the year the Board assisted six of these states—Alabama, Arkansas, Mississippi, Missouri, South Carolina, and Virginia—in providing supervisors to assume direction of comprehensive plans for the control of malaria within their borders. The state boards of health have made creditable progress in securing legislative appropriations for developing and aiding in measures for the control of malaria. It is estimated that six states expended at least $50,000 in this way during 1921. Future plans contemplate the expenditure of much larger sums in this work.

COUNTY-WIDE ANTI-MOSQUITO MEASURES

The effectiveness of county-wide malaria control operations under the direction of a full-time county health officer was demonstrated during the past year in several Alabama counties. The effort grew out of the work conducted during 1920 in several towns of the state, which awakened interest in malaria control and suggested to the State Board the idea of attempting to carry out similar measures in both towns and rural districts

[1] Following the original survey and before control effort is inaugurated the towns agree to defray certain items of expense associated with the work, as well as to set aside in future years the sums necessary for its maintenance. The agreement entered into with the towns contains careful estimates of original installation as well as maintenance costs. Persons who may be interested in the particulars of this phase of the work will be furnished a sample copy of the agreement upon application to the International Health Board, 61 Broadway, New York City.

through the county health departments. A malaria control engineer was added to the staff of the State Board, to co-operate with the county health officers, and Calhoun, Talladega, Sumter, Morgan, and Tuscaloosa counties were selected for the work. From the inception education and publicity were stressed.

Extent of Control Effort Undertaken. Active operations were begun April 1, 1921. By the end of April control effort was going forward in nineteen centers of population. Gradually other towns, and later the inhabitants of certain rural areas, took it up, until by the first of September it was under way in thirty-two towns and in fourteen rural districts. In some towns the regular city employes devoted to the work such time as was needed; in others the town marshal, assisted by prisoners, attended to it; in others still the towns paid nominal fees to some of their citizens. During the progress of operations in the five counties a total of 108 miles of ditches were dug, 1,298 miles of waters were oiled, and 86 miles of vegetation and other obstructions were cleared away from the banks of streams, ponds, and similar bodies of water. In addition 136 separate water deposits were stocked with the larvae-consuming top minnow, for the free distribution of which hatcheries were established at convenient locations in several of the counties.

Results and Cost. In the rural districts of all the counties many streams, lakes, and ponds were stocked with fish and many miles of ditches were dug. In one county in particular, where practically the sole source of Anopheles mosquitoes was stock ponds and small fish ponds, hundreds of these were stocked with Gambusia or were so cleaned by their owners that effective fish control was obtained. As a result a tremendous area was practically freed of Anopheles mosquitoes. The population protected in the several counties was 92,000, the total sum expended $3,108.11, and the cost per capita thirty-four cents.

ANTI-MOSQUITO MEASURES UNDER TROPICAL CONDITIONS

Efforts to adapt to tropical conditions the anti-mosquito measures whose value has been so convincingly demonstrated in the Southern States were continued in Porto Rico and Nicaragua during 1921. In both countries control is being sought by the use of top minnows, supplemented in Nicaragua by drainage and in Porto Rico by drainage and oiling. The complete results of the Porto Rican experiment are not yet known. The data at hand indicate that under tropical agricultural conditions in Porto Rico malaria cannot be controlled unless Anopheles breeding is prevented for a distance of at least 1½ miles from the nearest house.

Demonstration in La Puebla-Rivas, Nicaragua. During March and April, 1921, surveys were made in two towns of Nicaragua—Buenos Aires and La Puebla-Rivas—to determine the feasibility of undertaking malaria control by anti-mosquito measures. The surveys resulted

in the recommendation that experimental effort be undertaken in an area embracing approximately three square miles, forming part of the town of Rivas and the adjoining semi-rural district, really a part of the town, known as La Puebla. The work begun here in June has shown conclusively that anti-mosquito measures are applicable for the control of malaria in tropical towns, certainly under the conditions that exist in the towns of Nicaragua. The undertaking has awakened much interest in neighboring communities, a number of which are requesting assistance along similar lines.

Results and Costs in La Puebla-Rivas. No data are available for physicians' calls in earlier years. However, 43.6 per cent of the total population of 1,416 gave a history of attacks of malaria during the preceding twelve months. Examination of the blood of 200 persons, made for the purpose of checking the history index, yielded 139 positive results among 152 persons who gave positive histories, and indicated the histories to be approximately 90 per cent accurate.

During the period of control effort (June to December, 1921), which includes the period of highest malaria incidence (August to December), 27.7 per cent of the inhabitants had febrile attacks resembling malaria, indicating a diminution in the malaria rate of 36.5 per cent as compared with the incidence for the preceding year. A parasite index of 525 children, taken in August, 1921, and to be repeated in January and February and again in August of 1922, will give a truer estimate of results. There can be little doubt, however, that the degree of protection afforded was much higher than is suggested by the estimated reduction of 36.5 per cent, inasmuch as relapses unquestionably played an important part in raising the 1921 figures.

Excluding the expenditures for general supervision, the work was conducted at a per capita cost of seventy-four cents for the seven months it was in progress, or at an average rate of about one dollar for the year. This cost of original installation is slightly below the average cost of similar work in the Southern States. There is, moreover, every prospect that under Nicaraguan conditions the cost of maintenance will be considerably lower.

CONTROL BY STERILIZATION OF CARRIERS

The Mississippi delta is one of the regions in which the control of mosquito breeding is not economically feasible. In this region, therefore, experimental work in the control of malaria has been concerned with the sterilization of carriers. The work has been conducted under the general supervision of the Mississippi Department of Health and under the scientific direction of Dr. C. C. Bass, Professor of Experimental Medicine in Tulane University. It has been under way since 1916 and has dealt with many thousands of people. In the opinion of Dr. Bass its results indicate that with sufficient quinine available and the people sincerely desirous of being rid of the disease, *malaria may be controlled by quinine treatment alone* in any area of the world.

Extent of Experimental Effort. The study was conducted during 1916 and 1917 in an area of 328 square miles in Bolivar county, Mississippi. As a check on the results accomplished and while the figures for the Bolivar county work were being analyzed, work was also undertaken at the state prison farms in Sunflower and Quitman counties and at Parchman Penitentiary in Sunflower county.

The total population dealt with during the two years was about 35,000. During 1916 the work was conducted in an area of 225 square miles with a population of 20,040. A total of 37,841 blood specimens were examined during the year, and 13,403 quinine treatments were given. During 1917 an additional area of 103 square miles was covered and a large part of the 1916 area was investigated once or oftener to ascertain what effect the quinine treatment of the preceding year had had upon the incidence of malaria. A total of 45,889 blood specimens were examined during this year and 8,774 quinine treatments given.

Method of Treatment Experimentally Developed. The observations made during this two-year period shed considerable light upon many important questions involved in malaria control. Extensive tests of different salts and doses of quinine, carried on during 1917 at the prison farm in Sunflower county—because more dependable observations could be made on convicts than on free living people—together with experiments in methods of treatment followed by resurveys in various other communities during 1917 and 1918, made it possible to develop a standard treatment that gave promise of effectively immunizing the carriers.

Thorough investigations were undertaken to determine such questions as the total amount of quinine necessary to disinfect adults and children, the form in which the drug was most effective, the size of the daily dose, the manner in which the drug could be most conveniently and most effectively administered, the length of time over which treatment should be given, and the time or times of day at which it should be taken. Attention was also devoted to the question of whether or not there are persons to whom, because of a constitutional idiosyncrasy, the drug may not be administered.

Before adoption as part of the standard routine each particular phase of the treatment was experimentally tested and checked from carefully compiled records. The dosage finally decided upon was ten grains of quinine sulphate, with the following proportionate doses for children:

Age	*Proportion of Adult Dose*	*Dose for Children*
Under 1	0.05	½ grain
1 year	0.1	1 grain
2 years	0.2	2 grains
3-4 years	0.3	3 grains
5-7 years	0.4	4 grains
8-10 years	0.6	6 grains
11-14 years	0.8	8 grains
15 and over	1.0	10 grains

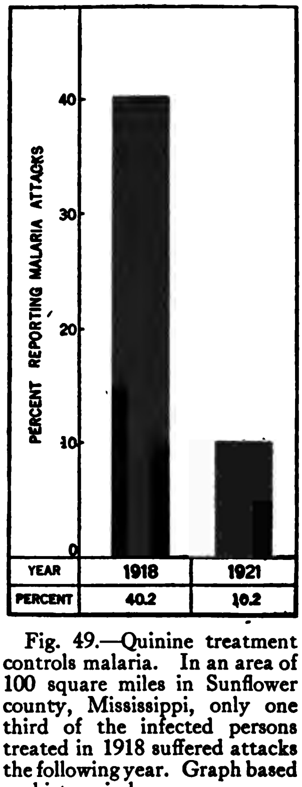
The medicine was to be taken at bedtime each night for a period of eight weeks. That the ten grains daily dose was about the smallest dose that could be depended upon to prevent multiplication of the parasites was

shown by the fact that clinical symptoms developed in a few instances among the several thousand persons who were taking it. According to data collected the treatment disinfected more than 90 per cent of the carriers, relapses occurring in very rare instances. The studies indicated that there were few people to whom it was unsafe to administer quinine.

In two communities prophylactic treatment was used; that is, smaller quantities of quinine were administered over a longer period of time—not in an effort to cure or disinfect, but merely to guard against acute attacks. The results indicated that if such treatment were continued during the transmission season for several years, it would effect a great reduction in the incidence of malaria. However, thirty-two persons among the 1,657 who took prophylactic treatment suffered malaria attacks and had to be put upon curative treatment.

Test of Treatment in Sunflower County, 1918. The next step was to test the efficacy of the immunizing treatment as a control measure in a typically malarious region. Accordingly, in 1918, a demonstration campaign was inaugurated in an area of 100 square miles located in Sunflower county, Mississippi. This area had a rural population of 8,052, with 1,000 additional persons residing in the town of Ruleville.

The proposed plan called for public meetings to advertise the scope and purpose of the work, for malaria surveys, for the furnishing of free quinine to all persons who gave positive histories or positive blood indices, and for following up the quinine treatment to see that it was taken on a regular weekly schedule. The work was to advance and to enter new communities as rapidly as conditions and facilities would permit.



YEAR	1918	1921
PERCENT	40.2	10.2

Fig. 49.—Quinine treatment controls malaria. In an area of 100 square miles in Sunflower county, Mississippi, only one third of the infected persons treated in 1918 suffered attacks the following year. Graph based on history index

Modification of Demonstration Effort, 1919–1921. This first demonstration achieved a considerable degree of malaria control. For the next year it was decided to discontinue *free* quinine treatment and to rely on county-wide publicity measures to stimulate the use of quinine in sufficient quantities for a cure. Practically nothing was done during 1919

Impounding Water Experiment Highly Promising. Only one of the experiments—that of impounding water in bayous which cannot be drained—has proceeded sufficiently far for definite conclusions to be reached. This method, which was developed originally by the Bureau of Entomology and given further test through the co-operation of the International Health Board, has yielded results far beyond expectation.

The bayous of the Mississippi delta are streams flowing through channels cut by the river at flood. By means of damming, the bayous are converted into a series of lakes. The marginal zone is transformed into a pasture by removing tangled undergrowth along the edges, and domestic animals are introduced to crop close the vegetation along the water's edge and permit the waves and top minnows to act effectively. The maintenance of a water level sufficiently high to suppress the growth of aquatic and semi-aquatic vegetation, and a clear margin, are the essential conditions of success.

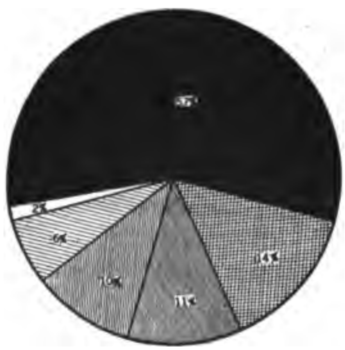


Fig. 50.—Proportionate rates of sickness from malaria and other diseases among rural population of seven counties in Southeast Missouri. Malaria caused 57 per cent of the total illness; digestive diseases, 14 per cent; respiratory diseases, 11 per cent; systemic infections (excluding malaria), 6 per cent; nervous diseases, 2 per cent. Ten per cent of the diseases could not be classified

Results of Impounding Experiment. A survey made more than a year after the completion of impounding gave only one collection of Anopheles larvae within the zone of control. Above and below it numerous specimens were obtained. The elimination of Anopheles breeding in the impounded section seemed to be the result of several factors, among which were: increased water depth, wave action, absence of vegetation near shores, absence of small organic and inorganic particles derived from submerged débris and vegetation, and finally larval reduction by fish.

Economic Return. Apart from the elimination of Anopheles breeding, several economic advantages resulted from the impounding experiment. Much additional pasturage was opened up; animals were provided with plenty of clean water throughout the dry season; and the supply of large edible fish became more abundant through the increased breeding produced under the more favorable conditions of the artificial lakes. The work of clearing the ground and constructing the dams cost only a little more than $600.

A MALARIA SURVEY IN SOUTHEASTERN MISSOURI

In counties or communities where the physicians and the people do not recognize malaria as an outstanding public health problem, surveys are necessary to determine the advisability of using public funds for its prevention. From August to December, 1921, Dr. Mark F. Boyd of the Board's field staff, in service with the Missouri State Board of Health, conducted such a survey in a group of seven counties containing a rural population of 147,845, constituting the southeastern corner of the state. He selected for intensive study a typical rural area of about 141 square miles, containing a population of 2,966. Some of his findings are interesting and significant.

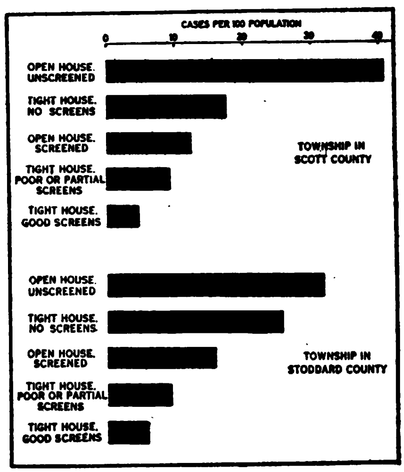


Fig. 51.—Effect of screening and construction of houses on incidence of malaria, two Southeast Missouri townships

These counties lie on the northern border of the recognized malaria zone for the United States, and yet Dr. Boyd finds malaria responsible for nearly 60 per cent of the illness. About 12 per cent of the entire rural population in the lowlands was found infected, with an estimated general malaria incidence of about 20 per cent. Of the people having attacks of malaria about 36 per cent consult a physician; about 16 per cent have no treatment; and the remainder dose themselves with chill tonics or quinine. None were found who had received what is regarded as the minimal dosage of quinine necessary to make a cure reasonably certain. The people living in open, unscreened houses have four times as much malaria as those living in well-built and well-screened dwellings. Difference in degree of protection against mosquitoes seems to be mainly responsible for the fact that the infection rate was found among farm-hands, 14.6 per cent; among tenants, 10.2 per cent; and among proprietors, 7.3 per cent.

The outstanding fact is that malaria in this region is on the decline; and that the principal cause of the decline is systematic agricultural drainage. Dr. Boyd's conclusion is that in this region anopheline control as a health measure is not economically feasible; and that the key to the control of the residual malaria lies in improving housing conditions to provide better protection against mosquitoes and educating the doctors and the people in proper standards of malaria treatment and the importance of effecting a cure (see Fig. 51).

V

FIGHTING MOSQUITOES WITH FISH

Fish played during 1921 a most important rôle in practically all the operations conducted against yellow fever and malaria. During the twenty years that have elapsed since 1900, when the United States Bureau of Fisheries began its investigations into the usefulness of the top minnow for destroying mosquito larvae, many experiments in the use of fish to keep down mosquito breeding had been made in various parts of the world, and some of them had yielded valuable and far-reaching results. Among them may be mentioned the work of the New Jersey Agricultural Experiment Station during the years 1902 to 1911; the observations of Geiger on the use of fish in rice fields near Lonoke, Arkansas; and the experimental work of Hildebrand, of the United States Bureau of Fisheries, near Augusta, Georgia, and elsewhere. Investigators in a number of other countries, particularly in India, have also made valuable contributions.

But the effectiveness of fish as a means of checking the breeding of malaria mosquitoes was first demonstrated under representative agricultural conditions in an experiment carried out by Dr. H. H. Howard in Hinds county, Mississippi, during the years 1918 and 1919. In a district thirty-six square miles in extent, with a population of 830 living in 172 homes, mosquito breeding was successfully controlled by the use of fish aided by only two inspectors. Fish were also used as an auxiliary but very effective measure of mosquito control in the campaign against yellow fever in Guayaquil in 1918 and 1919.

Elimination of Stegomyia Breeding Places in Guayaquil. In the city of Guayaquil, Ecuador, the main breeding places of the yellow fever mosquito—the large water-tanks—were covered and sealed, and fish were placed in the many smaller water containers that could not be so treated. The covering of the tanks greatly reduced the number of yellow fever cases; the use of fish in the smaller containers completed the eradication of the disease. Since then there has not been a single case of yellow fever in Guayaquil. During 1920, at a time when the supply of fish was temporarily exhausted, the percentage of containers other than tanks in which yellow fever mosquitoes were breeding rose rapidly from two to ten. The use of fish effected a notable economy in the cost of the campaign, making possible a reduction of the inspection personnel from 139 to 20.

Fish the Main Reliance in Peruvian Yellow Fever Epidemic, 1920–1921. For combating the severe yellow fever epidemic in Peru during 1920–1921, Dr. Hanson discontinued emptying and filtering and used fish in *all* classes of containers. The total of 750,000 fish that had been distributed by the end of 1921, brought down the mosquito

Fig. 52.—Several phases of yellow fever operations in Mexico and Central America. Home with water tank well screened; inspectors examining water barrels to detect possible Stegomyia breeding; fish distributor on way to landing place; oilers visiting homes to oil wells and small pools

Fig. 53.—Tank at Colima, Mexico, from which are distributed the small fish placed in water containers at the homes. The fish devour the larvae of yellow fever mosquitoes in water containers

Fig. 54.—Transporting fish from landing place to headquarters. Operations against yellow fever in Túxpan, Mexico

index and held it to a safe limit over the territory lying between the sea and the mountains and extending from the borders of Ecuador to Lima, a region 500 miles long and from fifty to seventy-five miles wide. Dr. Hanson states that in his opinion the control of breeding over so vast an area would have been impossible but for the use of fish.

Fish the Chief Weapon in Mexican Yellow Fever Campaign, 1920–1921. The successful use of fish in other regions led to their being adopted by Le Prince in the summer of 1920 for the eradication of yellow fever in and around Tampico. The plan adopted for this city and the oil camps adjacent to it consisted of an intensive fish campaign in which every type of water container was stocked with suitable fish. As supplementary aids, and for securing control in bodies of water in which fish were not effective, oiling and other methods were resorted to. From a visit to about 500 homes in the city of Tampico in 1921, Dr. Connor estimated that the use of fish had yielded an 80 per cent degree of control.

a. Use of fish in Vera Cruz. Dr. Caldwell, director of the yellow fever control campaign in and around Vera Cruz in 1921, after visiting Tampico in 1920 to familiarize himself with Le Prince's methods, decided upon a campaign along similar lines for Vera Cruz. Fully one half of the containers in this city were of a type that held but little water and could be easily emptied. For these, frequent inspection with emptying and cleaning proved to be the most satisfactory method of control. Containers of the other large class, including barrels, *pozos*, and tanks, were covered where practicable. Where this could not be done, the introduction of fish gave highly satisfactory control. For the few containers and other breeding places that could not be covered and in which fish could not be used, it was necessary to resort to oiling.

b. Fish prove effective in Merida. In Merida, Yucatan, the *aljibe* (stone cistern constructed under the *patio*) was the preferred breeding place of the Stegomyia. Next, in the order named, came tanks, barrels, *lejia*, and smaller containers. To free the *aljibe* of breeding, fish were resorted to because covering was too expensive. Fish were also employed with excellent results in barrels, tanks, and other large containers. Small containers were emptied and their number reduced as much as possible. Dr. Connor, in his report for May, 1921, says that of 12,324 water containers in which fish were used, inspection revealed not a single one harboring larvae or pupae.

Use of Fish in Central America. In Nicaragua fish played a part in controlling the outbreak of yellow fever in Managua in August, 1919. They were not generally used in that country, however, until early in 1921. Dr. Molloy reports that they disappear from small *pilas* filled by taps, and from rain barrels, when the water runs over. In tanks, and in *pilas* filled from wells, however, they have given excellent results.

In the malaria control studies conducted in the department of Rivas, Nicaragua, during 1921, small fish of the Poeciliidae species were relied on

exclusively to control breeding in streams and ponds. With proper clearing away of the underbrush and cleaning of the banks—a very inexpensive process—they yielded satisfactory control. To eliminate the principal breeding places of the region it was necessary merely to clean and straighten the banks of two rivers and give the top minnows a chance to perform their work. Fish were also used with excellent results to stop mosquito breeding in the artificial containers and wells found around houses.

In Salvador fish played an important rôle in maintaining, with a minimum inspection force, low mosquito indices in the principal cities. From hatcheries established in San Salvador and Sonsonate and in the Oriente, fish were widely distributed. In the opinion of Dr. Bailey fish alone would completely eliminate mosquito breeding if it were possible to secure proper care for all distributed and if the thousands of small containers in which they cannot be used could be emptied regularly or done away with.

A striking example of the part fish played in mosquito control is reported from the city of Sonsonate, Salvador. Even with persistent inspection of containers for many weeks it was practically impossible to reduce the house index below 4.2 per cent. Fish were then introduced, and in a very short time the index was reduced to 0.6 per cent. One year after the disappearance of yellow fever from Sonsonate, fish distribution was suspended, with the result that the percentage of houses in which Stegomyia were breeding rose rapidly from about 1 to 9 and the breeding in containers from 0.4 to 5.3 per cent.

In Guatemala fish have been effective in the classes of containers in which they can be used, but Dr. Vaughn reports that of the 30,000 containers in the yellow fever zone of that country only 2,900 are suitable for the use of fish. The larvae in those into which fish were introduced were greatly reduced in numbers despite the high mortality of the fish and the difficulty of keeping the containers adequately stocked.

Control of Malaria in the Southern States. In the Southern States fish are being extensively used to control the breeding of the malaria mosquito. In practically all the towns in which there have been demonstrations of malaria control by anti-mosquito measures during 1920 and 1921, they have been an important auxiliary to drainage and oiling and in many instances the chief or even sole reliance.

In a group of five counties in Alabama practically every farmer has convenient access to a minnow hatchery from which he is able to stock breeding places with fish as occasion arises. The city of Richmond, Virginia, has stocked all its fountains, reservoirs, and lakes with top minnows, and has established hatcheries to furnish the fish free of charge to any communities in the State that want them.

Kinds of Fish to be Used. In each locality a special study must be made of the kinds of fish available, of their habits, and of the conditions under which they are to be used. It is not safe to assume that because a certain species eats mosquito larvae in the laboratory, it will

be useful in an anti-mosquito campaign. The larvae-eating habits of the species must be studied under conditions that closely approach those under which it is to be used. All authorities agree that an indigenous fish is preferable. If an indigenous variety is not used, the imported species must be thoroughly acclimatized and allowed to adjust itself gradually to its new habitat. Small fish of the family Poeciliidae, widely distributed throughout the tropical and temperate zones, are the ones most extensively employed.

VI

COUNTY HEALTH WORK

The county offers a most effective unit of organization for providing adequate health service to the smaller towns and rural communities. The need of such service was strikingly demonstrated by field investigations conducted in the Southern States between the years 1910 and 1915. Study of the sanitary conditions surrounding 274,420 homes in 747 counties in eleven states showed that only 12,145, or 4.4 per cent, had latrine accommodations that could be regarded as satisfactory for the prevention of soil-borne diseases. One hundred thirty-four thousand and eight, or 48.8 per cent of the homes, had no latrines; 128,267 others, or 46.7 per cent of the total, had the grossly insanitary open-seat surface latrines. Only here and there were county health departments maintained, but in such counties the sanitary conditions were better at the time of original inspection, it was easier to secure needed improvements, and the advantages, once gained, were seldom lost.

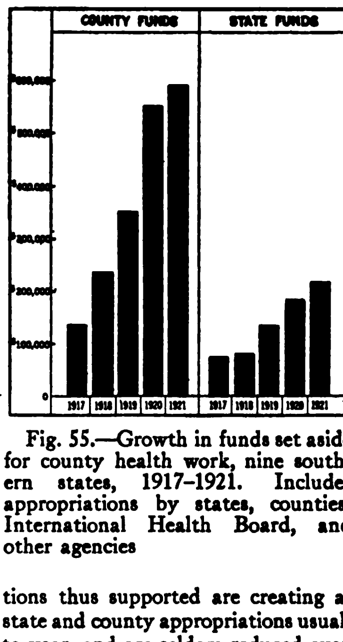


Fig. 55.—Growth in funds set aside for county health work, nine southern states, 1917–1921. Includes appropriations by states, counties, International Health Board, and other agencies

In the development of county health work the Board has been serviceable in providing funds for initial demonstrations. Its contributions have stimulated appropriations by counties and legislatures; and the demonstrations thus supported are creating a sustaining public sentiment. The state and county appropriations usually show wholesome growth from year to year, and are seldom reduced even in the face of the severe economic depression that has necessitated curtailment of many useful forms of service.

SCOPE AND EXTENT OF SERVICE

During the year 1921 co-operative projects in county health organization were carried out with the Board's participation in seventy-seven counties in sixteen states. The total sum appropriated by all the agen-

cies which co-operated in these projects was $758,904, of which the counties themselves provided $344,081, the state boards of health $156,658, and the Board $177,777. The remaining $80,387 came from other sources, including the United States Public Health Service and the American Red Cross, or from municipalities and private corporations or individuals.

Fig. 56.—Reduction of hookworm infection rates, 1911 to 1921, in fifty-two counties in ten southern states. Based on the original infection surveys of 1911–1914, when 57.8 per cent of 48,456 school children examined were found infected, and the special re-infection surveys made during 1920–1921, when 27.7 per cent of 27,524 school children were found infected

During the year 1921 new work was begun or arrangements for beginning it were completed in five states in addition to the twelve[1] in which it was previously in progress. These five states were Florida, Indiana, Louisiana, Maryland, and Missouri. There was thus a total of seventeen states in which operations were under way or contemplated at the close of the year. The extension of the work has been most rapid in North Carolina, which now has twenty-seven full-time health departments, and in Alabama, which has eighteen.

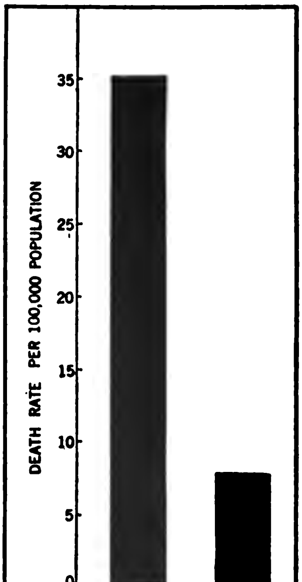
The plan of work pursued by the county health departments has been evolved from experience, is applicable under a wide variety of conditions, and has stood the test of time. Though there are minor differences to meet local conditions, the most important activities, which are more or less common to all the units, group themselves under the following main heads: (1) public health education; (2) sanitation; (3) control of communicable diseases; (4) adult and child hygiene. The demonstrations are so planned as to enable any county to undertake at the start, in a small way and with the least expenditure of money, the line or lines of work which for that particular county give promise of yielding the greatest results in lives saved and sickness prevented. Other activities are added and the health

[1] Alabama, Georgia, Kansas, Kentucky, Mississippi, New Mexico, North Carolina, South Carolina, Tennessee, Texas, Virginia, West Virginia.

department is expanded as the work proves effective and additional funds are provided.

PERSONNEL AND BUDGET

The personnel of the average county health department consists of a health officer, a sanitary inspector, an office assistant, and a public health nurse, though the staff is enlarged as occasion requires. The regular personnel serves on a full-time basis—a principle that is considered essential to the success of the work. The usual annual budget for a county of average size is $10,000, though the amount may be increased in the case of larger or more prosperous counties, or be reduced in counties whose population is small or resources limited. Sometimes two or more sparsely settled counties combine to operate a health department.



YEAR	1914 TO 1917	1918
DEATH RATE	35.3	7.8

Fig. 57.—Average number of deaths from typhoid fever per hundred thousand population, nine North Carolina counties. Record for years 1914 to 1917, before inauguration of county health work, compared with that for 1918, the year succeeding its inauguration

In no case do the funds appropriated for the health department budget represent the total sum that the county residents devote to health protection. The work of the department invariably stimulates private expenditures for sanitary and other improvements that far exceed the amounts of the county budgets. To cite one of many instances, the citizens of Tazewell county, Virginia, contracted or paid out in four months during 1921 a total of $60,000 for sanitary improvements recommended by the health department, although the total budget for the department during this period amounted to only $3,000.

Public health nurses are being employed in increasing numbers. They furnish a close bond of contact between the health staff and the people. When a case of communicable disease is quarantined a nurse visits the home and gives advice as to the methods to be followed in caring for the patient and in preventing the spread of the disease to other members of the family or to the community; when children are found to be

Fig. 58.—Health officer vaccinating children in rural school of Mason county, Kentucky. Small towns and rural communities, in increasing numbers, are providing themselves with health service of a type that has usually been found only in large cities

Fig. 59.—Trachoma clinic at Maysville, Kentucky, another feature of county health work as conducted in Mason county

Fig. 60.—Class of midwives, with their instructor (second from left), Davidson county, North Carolina. Many of the county health departments are making the instruction of midwives an important feature of their service

Fig. 61.—Children assembled to receive diphtheria immunization, Tyndale school, Lenoir county, North Carolina. The Schick test and toxin-antitoxin are proving effective weapons in the county health departments' fight against diphtheria

suffering from defects she consults with the parents and urges them to have the defects promptly corrected; and she renders valuable assistance to the health officer in the organization and conduct of clinics, in securing the co-operation of established welfare agencies, and in carrying out the general program of health education and community development.

ACTIVITIES UNDERTAKEN

The report for 1920 discussed somewhat in detail the activities usually embraced in the county health program. Of the newer activities undertaken by several of the departments during 1921, those concerned with county-wide effort for the control of malaria, with the use of the Schick test and toxin-antitoxin for the control of diphtheria, with measures against venereal diseases, and with the improvement of the physical condition of undernourished school children, may be worthy of separate discussion.

Anti-Malaria Work. The malaria operations conducted by the county health departments in Alabama have been fully discussed on pages 97 and 98. In other states also the departments undertook campaigns for mosquito control, advised suspected cases to have their blood microscopically examined and to consult a physician with regard to standard treatment if found positive, and in some instances they supplied free quinine in malarious districts. In the towns of Greenville and Farmville, North Carolina, it is reported that as a result of the anti-malaria work conducted during the past two years under the direction of the Pitt county health department, malaria was reduced at least 75 per cent.

Control of Diphtheria and Venereal Diseases. The health departments in many of the counties made extensive use of the Schick test and of toxin-antitoxin for controlling epidemics of diphtheria in the late summer and fall of 1921, when the disease became quite prevalent in many counties; and in other instances effort was devoted throughout the year to the control of venereal diseases. The measures against the latter disease consisted in the main of clinics, the closing of houses of prostitution, and caring for sufferers to insure their treatment until cured.

Nutritional Work in the Schools. The nutritional work undertaken in a number of counties effected much improvement not only in the weight of the children but also in their ability to keep up with their studies at school. In Montgomery county, Tennessee, 373 pupils from thirteen rural schools gained in weight within three to fifteen weeks an average of three pounds each as a result of such simple measures as serving them daily with milk and hot lunches and urging them to observe precautions in the care of the teeth, sleeping with windows open, and taking daily a sufficient amount of outdoor exercise. In one of the largest schools in this county, with 700 pupils, the percentage of underweight children was reduced during the school term of 1921 from 36 to 14. In

Kentucky counties without full-time health departments have had as many as twenty or more. In the city of Santa Fé, New Mexico, a threatened outbreak of scarlet fever was completely checked by daily inspection of school children and exclusion of suspects. The people had become much alarmed when this infection appeared in 1921, as several years before there had been a persistent and widespread outbreak with the deaths running as high as fifteen a day.

Reduction of Hookworm Incidence. The hookworm resurveys carried out during 1920 and 1921 (see discussion, pages 30 to 32) showed that the reduction of hookworm disease has been greatest in the counties in which county health departments have been in operation. This result may be attributed not only to the treatment of infected persons but, and more particularly, to the improvement in sanitation that has been effected in recent years. The resurveys in their turn have proved effective in stimulating public interest in further hookworm control and in general health work. In Baldwin county, Alabama, the authorities estimate that hookworm disease is costing the county not less than $100,000 annually, and the systematic work of the county health department is gradually eliminating this loss.

CONTINUATION AND EXPANSION

The educational value of the work and the demonstration of the benefits to be derived from it find strongest expression in the action of the counties year by year in providing for its continuation and expansion. Coincident with the increase in funds there has been steady increase in the personnel engaged. The benefits of the work in one county, being seen and appreciated in adjoining counties, have led to demands for similar work. In Kentucky during 1921, for example, six additional counties—all of them adjoining counties in which work was already in progress—laid the foundation for whole-time health departments to be organized later.

The state of Ohio, which maintains its county health work independently of outside assistance, stands at the head of the list of states with respect to the number of counties having whole-time health departments. In Virginia, Alabama, Georgia, and North Carolina, however, the number of co-operative county projects has increased with great rapidity. The work has also spread from state to state until, at the close of 1921, it was no longer confined to the Southern States but was under way or contemplated in practically all sections of the country.

Not only are departments once established usually continued, but the appropriations for maintaining them are enlarged year by year, the range of activities undertaken is broadened, and in the end the departments, usually established at first on a trial basis for a period of one to three years, have been made permanent as the results they achieved have demonstrated to the people the wisdom of continuing them. As illustrating the manner in which the funds made available for the work are increased year by year, the record for the following five counties may be cited:

	1917	1918	1919	1920	1921
Mason county, Ky.	$4,400	$6,600	$6,400	$3,500	$10,000
Wilson county, N. C.	3,485	6,205	5,665	8,870	12,196
Davidson county, N. C.	3,485	6,205	5,665	8,741	9,000
Northampton county, N. C.	2,904	6,332	5,702	8,232	9,000
Lenoir county, N. C.	2,904	6,332	5,702	8,482	9,000

COUNTY HEALTH WORK IN OTHER COUNTRIES

As county health work in the United States has been developed and its various lines of procedure have become established on a fairly satisfactory basis, it has in turn served to stimulate more active interest in rural health work in other countries. As a result the Board has been asked to aid in conducting demonstrations in general rural health programs in a number of countries, including Brazil, France, and Czechoslovakia. During the year the first rural health unit in Brazil was established in the county of Sertãozinho, in the state of São Paulo; and the prospects are excellent that within the next two years similar work will be developed in the states of São Paulo, Minas, Rio, and Rio Grande do Sul. With variations in working procedure to meet special conditions, and with adequate local appropriations available, it would seem feasible, through the extension of this type of work to rural regions in many quarters of the globe, to effect the same reduction in sickness and death rates and the same promotion of human welfare that has attended similar effort in the United States.

STATISTICAL TABLES

NOTES ON TABLE I

1. Table 1 on the following pages presents a concise statistical summary —by the main geographical divisions of the work, by states and countries, and by years—of the persons examined and treated in the world-wide campaign for the relief and control of hookworm disease aided by the International Health Board. It shows that in the twelve years from 1910 to 1921, inclusive, a total of 3,770,624 persons have been examined in thirty-four[1] different states and countries, of whom 2,232,756, or 59.2 per cent, were found infected. Of those infected, 2,020,396, or 90.5 per cent, were given one treatment; while 1,352,550, or 60.6 per cent, received two or more treatments.

2. Two treatments of a standard remedy remove, on the average, from 88 to 95 per cent of the worms harbored, depending upon the drug used and the method of administration; and it is seldom that they leave more than ten worms in the intestine. Thus, though some persons may remain lightly infected after two treatments, this number is nevertheless adequate to establish what may be termed a "practical" cure. One treatment, similarly, removes from 75 to 90 per cent of the worms.

3. Though the figures have been itemized by states and countries and by years, this has not been done primarily to invite comparison of the results for one state with those for another, or of one year's work with that of another. Too many variable factors affect the results for such comparisons to be entirely valid. For instance, among other reasons, the variations or fluctuations may be due to the density of population or severity of infection in the areas of operation, to size of working staff, or to differences in the plan of work pursued. In other instances, as in British Guiana in 1919 and Dutch Guiana in 1921, the figures may represent results for only a few months instead of a complete year.

4. The table includes the results of the early dispensary effort aided by the Rockefeller Sanitary Commission in the Southern States. These figures are not itemized by years, but are reported, under the respective states, as the total for the years 1910 to 1914, inclusive. Some of the work for 1914, separately indicated, was aided by the International Health Board. Since 1915, when work by the dispensary plan ceased in these states, the chief effort against hookworm disease has been directed

[1] See footnote 4, page 134.

toward the building and use of latrines. Therefore the aggregate figures for examination and treatment are not so large as in previous years, nor do they represent in all cases such thoroughgoing effort in the curative phase of the work.

5. In a number of countries operations were suspended during the war and resumed after its close; in others there have been temporary periods of suspension due to industrial depression, lack of trained directors, or similar causes.

6. Only the results of campaigns aided directly by the International Health Board or Rockefeller Sanitary Commission are included. In a number of countries, as in Brazil, government or voluntary agencies are conducting extensive independent campaigns against the disease, the results of which, if they could be included, would substantially increase the aggregate examinations and treatments.

TABLE 1: *Persons Examined and Treated for Hookworm Disease, 1910 to 1921, inclusive, in World-Wide Campaign Aided by International Health Board. Figures by main geographical divisions of work, by states and countries, and by years*

Division, Country, and State	Persons Examined	Persons Found Infected	Persons Given One Treatment[1]	Persons Given Two or More Treatments[2]	Per Cent Found Infected	Per Cent Given One Treatment	Per Cent Given Two or More Treatments
All Countries							
All Years	**3,770,624**	**2,232,756**	**2,020,396**	**1,352,550**	**59.2**	**90.5**	**60.6**
1910–1914	1,179,406	458,606	441,408	213,488	38.9	96.2	46.6
1914	35,397	17,791	16,106	11,925	50.3	90.5	67.0
1915	164,293	94,938	86,242	60,340	57.8	90.8	63.6
1916	223,976	133,744	126,834	93,302	59.7	94.8	69.8
1917	294,367	183,846	168,345	136,889	62.5	91.6	74.5
1918	374,330	249,103	215,394	164,577	66.5	86.5	66.1
1919	397,423	272,351	237,944	202,153	68.5	87.4	74.2
1920	479,916	340,456	297,322	240,983	70.9	87.3	70.8
1921	621,516	481,921	430,801	228,893	77.5	89.4	47.5
Divisions							
Southern States							
All Years	**1,413,000**	**518,668**	**498,333**	**239,921**	**36.7**	**96.1**	**46.3**
1910–1914	1,179,406	458,606	441,408	213,488	38.9	96.2	46.6
1914	9,211	2,434	2,264	653	26.4	93.0	26.8
1915	18,145	3,961	3,779	931	21.8	95.4	23.5
1916	22,169	4,569	4,544	2,939	20.6	99.5	64.3
1917	37,299	7,834	7,596	6,293	21.0	97.0	80.3
1918	44,241	8,074	7,636	4,681	18.3	94.6	58.0
1919	26,282	10,266	9,391	6,689	39.1	91.5	65.2
1920	44,644	12,732	12,528	1,554	28.5	98.4	12.2
1921	31,603	10,192	9,187	2,693	32.3	90.1	26.4

West Indies							
All Years	**309,439**	**190,611**	**194,772**	**155,951**	**61.6**	**91.7**	**81.8**
1915	63,062	38,026	33,648	24,559	60.3	88.5	64.6
1916	62,642	36,582	33,077	28,811	58.4	90.4	78.8
1917	75,779	46,051	42,739	40,738	60.8	92.8	88.5
1918	31,314	23,636	22,057	20,604	75.5	93.3	87.2
1919	20,350	14,537	13,534	12,962	71.4	93.1	89.2
1920	28,890	16,067	15,274	14,395	55.6	95.1	89.6
1921	27,402	15,712	14,443	13,882	63.6	91.9	88.4
Central America							
All Years	**949,398**	**581,078**	**520,603**	**385,627**	**61.3**	**89.6**	**66.4**
1914	5,321	2,907	2,562	578	54.6	88.1	19.9
1915	83,086	52,951	48,815	34,850	63.7	92.2	65.8
1916	131,520	85,235	82,461	57,534	64.8	96.7	67.5
1917	126,916	77,482	71,725	46,906	61.0	92.6	60.5
1918	169,531	107,449	94,176	71,078	63.5	87.6	66.2
1919	175,201	98,857	86,079	69,572	56.4	87.1	70.4
1920	134,439	77,537	67,160	50,427	57.7	86.6	65.0
1921	122,384	78,660	67,625	54,682	64.3	86.0	69.5
South America							
All Years	**420,807**	**343,738**	**291,429**	**215,820**	**81.7**	**84.8**	**62.8**
1918	10,490	6,922	5,894	4,208	66.0	85.1	60.8
1919	50,036	31,318	27,250	21,456	62.6	87.0	68.5
1920	109,337	83,475	73,901	61,276	76.4	88.5	73.4
1921	250,944	222,023	184,384	128,880	88.5	83.0	58.0
The East							
All Years	**678,980**	**598,661**	**535,259**	**355,231**	**88.2**	**89.4**	**59.3**
1914	20,865	12,450	11,280	10,694	59.7	90.6	85.9
1916	7,645	7,358	6,752	4,018	96.2	91.8	54.6
1917	54,373	52,479	46,285	42,952	96.5	88.2	81.8
1918	118,754	103,022	85,631	64,006	86.8	83.1	62.1
1919	125,554	117,373	101,690	91,474	93.5	86.7	78.0
1920	162,606	150,645	128,459	113,331	92.6	85.3	75.2
1921	189,183	155,334	155,162	28,756	82.1	99.9	18.5

TABLE 1: *Persons Examined and Treated for Hookworm Disease, 1910 to 1921, inclusive, in World-Wide Campaign Aided by International Health Board. Figures by main geographical divisions of work, by states and countries, and by years*

Division, Country, and State	Persons Examined	Persons Found Infected	Persons Given One Treatment[1]	Persons Given Two or More Treatments[2]	Per Cent Found Infected	Per Cent Given One Treatment	Per Cent Given Two or More Treatments
All Countries							
All Years	**3,770,624**	**2,232,756**	**2,020,396**	**1,352,550**	**59.2**	**90.5**	**60.6**
1910–1914	1,179,406	458,606	441,408	213,488	38.9	96.2	46.6
1914	35,397	17,791	16,106	11,925	50.3	90.5	67.0
1915	164,293	94,938	86,242	60,340	57.8	90.8	63.6
1916	223,976	133,744	126,834	93,302	59.7	94.8	69.8
1917	294,367	183,846	168,345	136,889	62.5	91.6	74.5
1918	374,330	249,103	215,394	164,577	66.5	86.5	66.1
1919	397,423	272,351	237,944	202,153	68.5	87.4	74.2
1920	479,916	340,456	297,322	240,983	70.9	87.3	70.8
1921	621,516	481,921	430,801	228,893	77.5	89.4	47.5
Divisions							
Southern States							
All Years	**1,413,000**	**518,668**	**498,333**	**239,921**	**36.7**	**96.1**	**46.3**
1910–1914	1,179,406	458,606	441,408	213,488	38.9	96.2	46.6
1914	9,211	2,434	2,264	653	26.4	93.0	26.8
1915	18,145	3,961	3,779	931	21.8	95.4	23.5
1916	22,169	4,569	4,544	2,939	20.6	99.5	64.3
1917	37,299	7,834	7,596	6,293	21.0	97.0	80.3
1918	44,241	8,074	7,636	4,681	18.3	94.6	58.0
1919	26,282	10,266	9,391	6,689	39.1	91.5	65.2
1920	44,644	12,732	12,528	1,554	28.5	98.4	12.2
1921	31,603	10,192	9,187	2,693	32.3	90.1	26.4

WEST INDIES							
All Years	**309,439**	**190,611**	**194,772**	**155,951**	**61.6**	**91.7**	**81.8**
1915	63,062	38,026	33,648	24,559	60.3	88.5	64.6
1916	62,642	36,582	33,077	28,811	58.4	90.4	78.8
1917	75,779	46,051	42,739	40,738	60.8	92.8	88.5
1918	31,314	23,636	22,057	20,604	75.5	93.3	87.2
1919	20,350	14,537	13,534	12,962	71.4	93.1	89.2
1920	28,890	16,067	15,274	14,395	55.6	95.1	89.6
1921	27,402	15,712	14,443	13,882	63.6	91.9	88.4
CENTRAL AMERICA							
All Years	**949,398**	**581,078**	**520,603**	**385,627**	**61.3**	**89.6**	**66.4**
1914	5,321	2,907	2,562	578	54.6	88.1	19.9
1915	83,086	52,951	48,815	34,850	63.7	92.2	65.8
1916	131,520	85,235	82,461	57,534	64.8	96.7	67.5
1917	126,916	77,482	71,725	46,906	61.0	92.6	60.5
1918	169,531	107,449	94,176	71,078	63.5	87.6	66.2
1919	175,201	98,857	86,079	69,572	56.4	87.1	70.4
1920	134,439	77,537	67,160	50,427	57.7	86.6	65.0
1921	122,384	78,660	67,625	54,682	64.3	86.0	69.5
SOUTH AMERICA							
All Years	**420,807**	**343,738**	**291,429**	**215,820**	**81.7**	**84.8**	**62.8**
1918	10,490	6,922	5,894	4,208	66.0	85.1	60.8
1919	50,036	31,318	27,250	21,456	62.6	87.0	68.5
1920	109,337	83,475	73,901	61,276	76.4	88.5	73.4
1921	250,944	222,023	184,384	128,880	88.5	83.0	58.0
THE EAST							
All Years	**678,980**	**598,661**	**535,259**	**355,231**	**88.2**	**89.4**	**59.3**
1914	20,865	12,450	11,280	10,694	59.7	90.6	85.9
1916	7,645	7,358	6,752	4,018	96.2	91.8	54.6
1917	54,373	52,479	46,285	42,952	96.5	88.2	81.8
1918	118,754	103,022	85,631	64,006	86.8	83.1	62.1
1919	125,554	117,373	101,690	91,474	93.5	86.7	78.0
1920	162,606	150,645	128,459	113,331	92.6	85.3	75.2
1921	189,183	155,334	155,162	28,756	82.1	99.9	18.5

TABLE 1—*Continued*

Division, Country, and State	Persons Examined	Persons Found Infected	Persons Given One Treatment[1]	Persons Given Two or More Treatments[2]	Per Cent Found Infected	Per Cent Given One Treatment	Per Cent Given Two or More Treatments
South Carolina—Cont'd.							
1918[3]	931	24	....	....	2.6	....	....
1919	4,966	1,057	327	....	21.3	30.9	....
1920	2,268	989	965	....	43.6	97.6	....
1921	880	147	110	....	16.7	74.8	....
Tennessee							
All Years	81,582	22,310	21,680	16,087	27.3	97.2	72.1
1910–1914	74,997	21,410	20,979	15,828	28.5	98.0	73.9
1915[3]	1,172	116	116	20	9.9	100.0	17.2
1916	1,217	49	48	23	4.0	....	....
1917	856	129	126	71	15.1	97.7	55.0
1918	127	3	3	2	2.4	....	....
1919	378	17	9	3	4.5	....	....
1920	608	26	17	7	4.3	....	....
1921	2,227	560	382	133	25.1	68.2	23.8
Texas							
All Years	89,482	19,947	19,492	4,861	22.3	97.7	24.4
1910–1914	63,376	17,790	17,490	3,588	28.1	98.3	20.2
1916[3]	2,801	570	568	357	20.3	99.6	62.6
1917	7,084	1,058	1,021	662	14.9	96.5	62.6
1918	11,025	81	70	51	.7	....	....
1919	3,044	322	230	103	10.6	71.4	32.0
1920	2,115	123	112	100	5.8	91.1	81.3
1921	37	3	1	....	....	....	....

Virginia							
All Years	**102,516**	**18,745**	**18,660**	**16,395**	**18.3**	**99.5**	**87.5**
1910–1914	81,191	17,137	17,057	15,941	21.1	99.5	93.0
1914[3]	966	36	36	31	3.7	....	....
1915[3]	3,740	344	343	84	9.2	99.7	24.4
1916	7,706	493	493	171	6.4	100.0	34.7
1917	4,873	195	195	146	4.0	100.0	74.9
1918	2,923	89	85	21	3.0	....	....
1919	238	1	1	....	.4	....	....
1920[3]	307	1	1	1	.3	....	....
1921	572	449	449	....	78.5	100.0	....
WEST INDIES							
Antigua							
All Years	**18,599**	**2,919**	**2,634**	**2,566**	**15.7**	**90.2**	**87.9**
1916[3]	7,477	2,229	2,054	2,031	29.8	92.1	91.1
1917[3]	11,122	690	580	535	6.2	84.1	77.5
British Guiana							
All Years	**71,322**	**44,073**	**39,906**	**35,394**	**61.8**	**90.5**	**80.3**
1915	21,070	13,135	11,903	10,039	62.3	90.6	76.4
1916	18,498	9,808	8,263	6,225	53.0	84.2	63.5
1917	16,044	9,508	8,906	8,722	59.3	93.7	91.7
1918	11,719	8,727	8,175	7,900	74.5	93.7	90.5
1919[3]	3,991	2,895	2,659	2,508	72.5	91.8	86.6
Dutch Guiana							
All Years	**18,494**	**16,762**	**15,544**	**14,792**	**90.6**	**92.7**	**88.2**
1916	4,411	3,900	3,667	3,414	88.4	94.0	87.5
1917	13,159	12,045	11,133	10,664	91.5	92.4	88.5
1921[3]	924	817	744	714	88.4	91.1	87.4
Grenada							
All Years	**33,164**	**22,120**	**20,571**	**15,650**	**65.2**	**99.6**	**70.8**
1915	20,042	12,652	11,522	8,064	63.1	91.1	63.7
1916	5,312	4,226	4,147	2,950	79.6	98.1	69.8
1917	7,810	5,242	4,902	4,636	67.1	93.5	88.4

TABLE 1—*Continued*

Division, Country, and State	Persons Examined	Persons Found Infected	Persons Given One Treatment[1]	Persons Given Two or More Treatments[2]	Per Cent Found Infected	Per Cent Given One Treatment	Per Cent Given Two or More Treatments
Jamaica							
All Years	**26,397**	**8,552**	**7,705**	**7,129**	**32.4**	**90.1**	**83.4**
1919[3]	2,842	1,552	1,346	1,291	54.6	86.7	83.2
1920[3]	13,748	3,915	3,605	3,203	28.5	92.1	81.8
1921	9,807	3,085	2,754	2,635	31.5	89.3	85.4
St. Lucia							
All Years	**37,436**	**22,572**	**21,589**	**17,661**	**60.3**	**95.6**	**78.2**
1915	7,924	4,436	4,106	2,177	56.0	92.6	49.1
1916	6,003	2,336	2,201	1,904	38.9	94.2	81.5
1917	4,601	3,060	2,962	2,653	66.5	96.8	86.7
1918	5,004	3,126	2,892	2,068	62.5	92.5	66.2
1919	4,350	2,597	2,547	2,364	59.7	98.1	91.0
1920	6,373	4,743	4,656	4,331	74.4	98.2	91.3
1921	3,181	2,274	2,225	2,164	71.5	97.8	95.2
St. Vincent							
All Years	**21,915**	**12,758**	**11,905**	**11,383**	**58.2**	**93.3**	**89.2**
1915[3]	3,822	1,676	1,590	1,562	43.9	94.9	93.2
1916	7,494	4,062	3,748	3,653	54.2	92.3	89.9
1917	9,482	6,065	5,683	5,303	64.0	93.7	87.4
1918[3]	1,117	955	884	865	85.5	92.6	90.6

Trinidad							
All Years	82,112	60,855	54,918	51,376	74.1	90.2	84.4
1915[4]	10,204	6,127	4,527	2,717	60.0	73.9	44.3
1916	13,447	10,021	8,997	8,634	74.5	89.8	86.2
1917	13,561	9,441	8,573	8,225	69.6	90.8	87.1
1918	13,474	10,828	10,106	9,771	80.4	93.3	90.2
1919[3]	9,167	7,493	6,982	6,799	81.7	93.2	90.7
1920	8,769	7,409	7,013	6,861	84.5	94.7	92.6
1921	13,490	9,536	8,720	8,369	70.7	91.4	87.8
CENTRAL AMERICA							
Costa Rica							
All Years	303,106	158,358	146,622	101,802	52.3	2.6	64.3
1915	30,297	19,401	18,816	12,152	64.0	97.0	62.6
1916	40,579	22,608	22,037	9,899	55.7	97.5	43.8
1917	48,488	29,940	28,909	19,180	61.7	96.6	64.1
1918	56,371	29,898	27,487	19,154	53.0	91.9	64.1
1919	64,371	29,872	26,551	22,798	46.4	88.9	76.3
1920[3]	30,575	9,700	8,163	6,368	31.7	84.2	65.6
1921	32,425	16,939	14,659	12,251	52.2	86.5	72.3
Guatemala							
All Years	201,250	131,558	117,380	106,283	65.4	89.2	80.8
1915[3]	25,587	15,001	13,783	11,851	58.6	91.9	79.0
1916	39,596	26,665	25,961	23,618	67.3	97.4	88.6
1917[3]	12,934	7,095	6,693	6,518	54.9	94.3	91.9
1918[3]	32,861	22,299	19,950	19,057	67.9	89.5	85.5
1919	44,495	28,752	25,283	23,639	64.6	87.9	82.2
1920	21,460	12,805	11,429	10,402	59.7	89.3	81.2
1921	24,317	18,941	14,281	11,198	77.9	75.4	59.1

TABLE 1—*Continued*

Division, Country, and State	Persons Examined	Persons Found Infected	Persons Given One Treatment[1]	Persons Given Two or More Treatments[2]	Per Cent Found Infected	Per Cent Given One Treatment	Per Cent Given Two or More Treatments
Nicaragua							
All Years	**129,780**	**88,036**	**78,869**	**45,010**	**67.8**	**89.6**	**51.1**
1915[3]	2,192	1,659	1,298	18	75.7	78.2	1.1
1916[3]	12,829	9,073	8,362	1,166	70.7	92.2	12.9
1917	33,781	18,422	16,950	5,388	54.5	92.0	29.2
1918	19,786	15,016	13,679	9,286	75.9	91.1	61.8
1919	12,246	5,820	4,829	1,657	47.5	83.0	28.5
1920	33,128	25,272	22,035	16,615	76.3	87.2	65.7
1921	15,818	12,774	11,716	10,880	80.8	91.7	85.2
Panama							
All Years	**125,979**	**99,381**	**90,486**	**68,450**	**78.9**	**91.0**	**68.9**
1914[3]	5,321	2,907	2,562	578	54.6	88.1	19.9
1915	25,010	16,890	14,918	10,829	67.5	88.3	64.1
1916	30,094	24,193	23,747	21,340	80.4	98.2	88.2
1917	16,676	14,088	13,262	11,126	84.5	94.1	79.0
1918	16,185	13,656	11,966	9,537	84.4	87.6	69.8
1919	15,307	13,490	11,812	8,313	88.1	87.6	61.6
1920	13,104	10,050	8,353	4,009	76.7	83.1	39.9
1921	4,282	4,107	3,866	2,718	95.9	94.1	66.2
Salvador							
All Years	**188,283**	**103,745**	**87,246**	**64,082**	**55.1**	**84.1**	**61.8**
1916[3]	8,422	2,696	2,354	1,511	32.0	87.3	56.0
1917	15,037	7,937	5,911	4,694	52.8	74.5	59.1
1918	44,328	26,580	21,094	14,044	60.0	79.4	52.8
1919	38,782	20,923	17,604	13,165	54.0	84.1	62.9
1920	36,172	19,710	17,180	13,033	54.5	87.2	66.1
1921	45,542	25,899	23,103	17,635	56.9	89.2	68.1

South America							
Brazil [4]							
All Years	**375,568**	**300,932**	**250,684**	**179,501**	**80.1**	**83.3**	**59.6**
1918 [3]	10,490	6,922	5,894	4,208	66.0	85.1	60.8
1919	50,036	31,318	27,250	21,456	62.6	87.0	68.5
1920	102,474	77,432	68,207	56,923	75.6	88.1	73.5
1921	212,568	185,260	149,333	96,914	87.2	80.6	52.3
Colombia							
Both Years	**45,239**	**42,806**	**40,745**	**36,319**	**94.6**	**95.2**	**84.8**
1920 [3]	6,863	6,043	5,694	4,353	88.1	94.2	72.0
1921	38,376	36,763	35,051	31,966	95.8	95.3	87.0
The East							
Australia [4]							
Both Years	**38,224**	**2,193**	**2,075**	**1,609**	**5.7**	**94.6**	**73.4**
1920 [3]	5,008	350	345	345	7.0	98.6	98.6
1921	33,216	1,843	1,730	1,264	5.5	93.9	68.6
Borneo							
1921 [3]	**11,337**	**10,568**	**10,568**	**9,951**	**93.2**	**100.0**	**94.2**
Ceylon							
All Years	**384,099**	**372,587**	**319,698**	**297,973**	**97.0**	**85.8**	**80.0**
1916 [3]	7,645	7,358	6,752	4,018	96.2	91.8	54.6
1917	42,828	41,613	35,675	33,440	97.2	85.7	80.4
1918	61,287	59,448	50,374	47,181	97.0 [5]	84.7	79.4
1919	107,190	103,974	88,602	84,712	97.0 [5]	85.2	81.5
1920	143,482	139,177	117,337	112,089	97.0 [5]	84.3	80.5
1921	21,667	21,017	20,958	16,533	97.0 [5]	99.7	78.7
China							
Both Years	**14,529**	**8,493**	**6,542**	**2,669**	**58.5**	**77.0**	**31.4**
1918 [3]	12,504	7,556	5,694	2,519	60.4	75.4	33.3
1919 [3]	2,025	937	848	150	46.3	90.5	16.0

TABLE 1—*Continued*

Division, Country, and State	Persons Examined	Persons Found Infected	Persons Given One Treatment[1]	Persons Given Two or More Treatments[2]	Per Cent Found Infected	Per Cent Given One Treatment	Per Cent Given Two or More Treatments
Egypt							
1914	20,865	12,450	11,280	10,694	59.7	90.6	85.9
Fiji							
Both Years	6,624	5,975	5,780	5,551	90.2	96.7	92.9
1917[3]	3,434	3,088	3,010	2,877	89.9	97.5	93.2
1918[3]	3,190	2,887	2,770	2,674	90.5	95.9	92.6
Seychelles							
All Years	30,912	24,717	23,826	22,537	80.0	96.4	91.2
1917[3]	8,111	7,778	7,600	6,635	95.9	97.7	85.3
1918	10,475	9,113	8,671	8,449	87.0	95.1	92.7
1919	10,801	6,924	6,702	6,612	64.1	96.8	95.5
1920[3]	1,525	902	853	841	59.1	94.6	93.2
Siam							
All Years	172,390	161,678	155,490	2,247	93.8	96.2	2.6
1918	31,298	24,018	18,122	3,183	76.7	75.5	13.3
1919	5,538	5,538	5,538	....	100.0	100.0	....
1920[3]	12,591	10,216	9,924	56	81.1	97.1	.5
1921	122,963	121,906	121,906	1,008	99.1	100.0	.8

[1] One treatment removes from 75 to 90 per cent of worms; see page 122.
[2] Two treatments remove from 88 to 95 per cent of worms; see page 122.
[3] Represents part-year effort only.
[4] States of Brazil and Australia not indicated separately.
[5] Treatment administered without preliminary diagnosis. Extensive study had previously demonstrated practically every person to be infected.

TABLE 2: *Expenditures of the International Health Board for the*

Activity, State, and Country	July 1, 1913 Dec. 31, 1914	1915	1916	1917
Grand Total........	**$157,731.08**	**$333,461.91**	**$506,087.48**	**$578,367.75**
Relief and Control of Hookworm Disease..	93,202.74	234,592.13	306,574.04	369,988.49
County Health Work.	....	....	....	182.95
Malaria Control.....	....	....	54,496.97	39,978.58
Yellow Fever Control	....	....	41,863.17	9,344.03
Tuberculosis in France............	....	....	....	51,856.24
Public Health Education.............	....	....	9,256.74	12,376.63
Public Health Laboratory Service.......	....	....	....	....
Philippine Hospital Ship..............	....	25,000.00	....	....
Investigation of Sewage Disposal at Rural Homes......	....	....	664.39	5,359.11
Field Staff Salaries, Expenses, etc., not Prorated to Specific Budgets.......	15,351.20	9,877.95	4,687.45	9,232.30
Miscellaneous.......	15,138.35	15,057.65	27,628.35	18,191.76
Administration.......	34,038.79	48,934.18	60,916.37	61,857.66
Relief and Control of Hookworm Disease	**93,202.74**	**234,592.13**	**306,574.04**	**369,988.49**
Southern States[1]...	....	89,565.64	47,565.09	53.446.11
West Indies.......	38,707.33	52,393.83	88,845.12	.87,764.12
Central America ...	19,552.54	55,379.47	88,123.29	98,483.25
South America.....	....	....	4,779.77	43,309.16
The East..........	19,466.66	37,253.19	77,260.77	84,912.45
Miscellaneous......	15,476.21	....	....	2,073.40
Southern States:[1]	....	**89,565.64**	**47,565.09**	**'53,446.11**
Alabama..........	....	4,343.33	....	1,235.97
Arkansas.........	....	....	....	2,462.59
Georgia...........	....	22,822.59	....	2,436.95
Kentucky.........	....	9,766.49	4,866.63	2,200.00
Louisiana.........	....	529.38	1,813.19	1,278.66
Mississippi........	....	11,719.14	8,786.77	9,223.36
North Carolina....	....	3,026.99	3,282.34	8,548.71
South Carolina.....	....	5,872.56	5,643.52	7,967.22
Tennessee.........	....	11,889.72	5,797.57	6,585.02
Texas............	....	8,175.55	9,971.36	5,170.48

[1] In September, 1917, the hookworm work in the Southern States began to be absorbed in the being longer in some states than in others, it was not possible to announce until the end of 1920 regular functions, responsibility for all efforts directed toward the relief and control of hookworm

Years 1913–1914 to 1921, Inclusive, Covering All Activities

1918	1919	1920	1921	Total
$1,121,862.86	**$1,436,355.00**	**$1,658,572.61**	**$1,701,185.96**	**$7,493,624.65**
457,953.94	509,091.99	621,520.98	457,486.99	3,050,411.30
2,494.53	2,439.25	8,182.77	167,765.19	181,064.69
26,489.29	34,965.08	133,929.02	150,551.39	440,410.33
46,639.17	94,526.42	139,757.40	239,057.53	571,187.72
433,030.43	602,775.78	518,013.51	359,540.31	1,965,216.27
36,642.82	38,367.71	68,373.54	89,094.44	254,111.88
....	....	....	16,109.70	16,109.70
12,500.00	6,500.00	....	....	44,000.00
4,288.01	778.60	....	....	11,090.11
5,345.82	21,701.87	26,074.89	38,936.95	131,208.43
23,034.17	46,901.63	51,248.30	59,652.90	256,853.11
73,444.68	78,306.67	91,472.20	122,990.56	571,961.11
457,953.94	**509,091.99**	**621,520.98**	**457,486.99**	**3,050,411.30**
87,284.58	110,860.17	136,019.06	15,730.39	540,471.04
57,800.06	48,457.24	61,857.73	85,541.60	521,367.03
113,545.86	111,684.19	98,303.98	77,920.73	662,993.31
97,031.00	157,555.86	206,486.22	150,422.24	659,584.25
97,932.47	80,014.39	113,472.55	121,805.46	632,117.94
4,359.97	520.14	5,381.44	6,066.57	33,877.73
87,284.58	**110,860.17**	**136,019.06**	**15,730.39**	**540,471.04**
5,922.09	5,283.74	17,256.71	....	34,041.84
2,784.41	....	....	....	5,247.00
5,418.95	4,604.21	4,525.39	....	39,808.09
2,064.97	1,978.40	16,599.03	....	37,475.52
1,317.93	1,370.18	....	....	6,309.34
9,427.52	15,773.21	20,709.72	....	75,639.72
15,775.89	13,924.04	10,463.00	....	55,020.97
13,870.12	14,754.86	17,210.63	....	65,318.91
6,642.20	10,201.59	13,533.22	....	54,649.32
9,362.85	22,380.20	14,723.99	....	69,784.43

programs of the rapidly developing county departments of health. The period of transition that in all the states the county health departments would henceforth assume as one of their and other soil-borne diseases.

TABLE 2: *Expenditures of the International Health Board for the*

ACTIVITY, STATE, AND COUNTRY	July 1, 1913 Dec. 31, 1914	1915	1916	1917
RELIEF AND CONTROL OF HOOKWORM DISEASE—*Continued*				
Southern States—*Cont'd*				
Virginia..........	$........	$6,622.97	$7,403.71	$6,337.15
Administration.....	....	....	....	....
County Dispensary Work in the South	....	4,796.92	....	....
Resurveys.........	....	....	....	....
West Indies:	**38,707.33**	**52,393.83**	**88,845.12**	**87,764.12**
Antigua...........	3,780.06	1,738.23	9,316.68	4,758.87
Barbados (survey)..	....	....	1,651.31	....
British Guiana[1] ...	9,711.36	13,300.06	18,554.45	19,231.23
Cayman Islands (survey)........	....	....	....	1,795.16
Dutch Guiana[1]	....	3,260.93	11,672.46	19,168.40
Grenada...........	7,003.76	10,593.37	10,154.65	7,778.80
Jamaica..........	....	....	....	....
Porto Rico........	....	....	....	....
Santo Domingo (survey)........	....	....	....	....
St. Lucia..........	4,742.30	6,048.76	6,295.20	6,865.60
St. Vincent........	4,335.18	4,834.00	6,825.15	9,384.18
Tobago (survey)...	....	....	....	1,072.22
Trinidad..........	9,134.67	8,242.19	15,104.04	10,898.37
Administration.....	....	4,376.29	9,271.18	6,811.29
Central America:	**19,552.54**	**55,379.47**	**88,123.29**	**98,483.25**
British Honduras (survey)	....	....	4,273.47	....
Costa Rica........	9,174.60	16,913.06	18,089.98	21,752.31
Guatemala........	185.53	10,432.69	11,954.29	13,346.70
Nicaragua........	375.00	7,587.80	18,430.69	19,418.74
Panama..........	9,817.41	18,828.55	24,449.62	22,881.75
Salvador..........	....	....	10,925.24	21,083.75
Administration.....	....	1,617.37	....	....
South America:	....	....	**4,779.77**	**43,309.16**
Brazil............	....	....	4,779.77	43,309.16
Colombia.........	....	....	....	....

[1] For administrative reasons British and Dutch Guiana, although on

Years 1913–1914 to 1921, Inclusive, Covering All Activities—Cont'd

1918	1919	1920	1921	Total
$5,947.86	$10,012.42	$14,965.17	$........	$51,289.28
8,749.79	10,577.32	6,032.20	....	25,359.31
....	....	....	....	4,796.92
....	....	....	15,730.39	15,730.39
57,800.06	**48,457.24**	**61,857.73**	**85,541.60**	**521,367.03**
....	....	....	....	19,593.84
....	....	....	....	1,651.31
16,504.11	9,984.28	486.37	1,281.02	89,052.88
....	....	....	....	1,795.16
4,389.11	613.23	570.34	12,917.66	52,592.13
1,833.74	....	....	....	37,364.32
3,937.85	9,832.48	18,400.09	16,949.24	49,119.66
....	....	7,823.35	18,290.86	26,114.21
....	....	1,077.07	....	1,077.07
8,152.28	8,109.32	11,444.57	8,545.88	60,203.91
6,383.25	....	....	17,489.50	49,251.26
....	....	....	....	1,072.22
12,301.48	15,293.43	16,016.71	....	86,990.89
4,298.24	4,624.50	6,039.23	10,067.44	45,488.17
113,545.86	**111,684.19**	**98,303.98**	**77,920.73**	**662,993.31**
....	....	....	....	4,273.47
21,330.40	20,492.01	20,219.60	14,061.66	142,033.62
20,816.27	19,514.73	17,126.43	15,362.58	108,739.22
22,454.30	26,164.44	18,745.12	21,479.43	134,655.52
24,312.26	18,565.05	20,061.02	23,496.22	162,411.88
17,573.90	17,162.10	14,973.80	3,520.84	85,239.63
7,058.73	9,785.86	7,178.01	....	25,639.97
97,031.00	**157,555.86**	**206,486.22**	**150,422.24**	**659,584.25**
97,031.00	155,430.38	193,560.95	131,787.27	625,898.53
....	2,125.48	12,925.27	18,634.97	33,685.72

the mainland of South America, are considered West Indian colonies.

TABLE 2: *Expenditures of the International Health Board for the*

Activity, State, and Country	July 1, 1913 Dec. 31, 1914	1915	1916	1917
Relief and Control of Hookworm Disease *Continued*				
The East:	**$19,466.66**	**$37,253.19**	**$77,260.77**	**$84,912.45**
Uncinariasis Commission to Orient	....	15,504.31	19,406.36	16,572.64
Australia	....	....	....	....
British North Borneo	....	....	....	....
British Solomon Islands (survey)	....	....	....	....
Ceylon	....	2,073.07	21,585.84	30,340.00
China	....	....	....	3,981.58
Egypt	19,466.66	6,608.12	....	....
Fiji	....	....	3,386.37	5,776.92
Java (survey)	....	....	327.66	....
India (survey)	....	....	....	....
Mauritius (survey)	....	....	....	....
Papua and Queensland	....	....	....	4,074.84
Seychelles Islands	....	589.06	3,933.29	7,409.69
Siam	....	....	6,147.52	6,458.57
Administration	....	12,478.63	22,473.73	10,298.21
Miscellaneous:	**15,476.21**	....	....	**2,073.40**
Research in Life History of Hookworm Eggs and Larvae	....	....	....	....
Study of Methods of Diagnosing Hookworm Disease	....	....	....	....
Conferences, Health Officers of Southern States	....	....	....	2,073.40
Motion Picture Film on Hookworm Disease	....	....	....	....
Lecture Charts	....	....	....	....
Salvador, Portable House and Office	....	....	....	....
Salvador, Loss from Earthquake	....	....	....	....
Thymol	15,476.21	....	....	....
Dutch Guiana, Care and Storage of Motor Boat and Supplies	....	....	....	....

Years 1913–1914 to 1921, Inclusive, Covering All Activities—Cont'd

1918	1919	1920	1921	Total
$97,932.47	**$80,014.39**	**$113,472.55**	**$121,805.46**	**$632,117.94**
....	....	....	....	51,483.31
....	15,902.95	35,417.41	39,912.29	91,232.65
....	....	3,106.23	7,440.10	10,546.33
....	....	....	1,378.85	1,378.85
36,041.44	32,497.87	33,779.28	23,689.34	180,006.84
12,400.87	12,187.58	....	....	28,570.03
....	....	....	....	26,074.78
5,579.84	....	....	498.64	15,241.77
....	....	....	....	327.66
....	....	7,810.00	12,496.30	20,306.30
....	....	5,688.56	....	5,688.56
18,633.50	....	....	....	22,708.34
8,089.06	8,291.90	4,643.03	....	32,956.03
13,042.15	7,514.66	15,850.03	18,429.18	67,442.11
4,145.61	3,619.43	7,178.01	17,960.76	78,154.38
4,359.97	**520.14**	**5,381.44**	**6,066.57**	**33,877.73**
....	....	....	3,618.83	3,618.83
....	43.95	....	500.00	543.95
2,990.76	....	2,488.71	....	7,552.87
....	....	2,817.73	1,584.74	4,402.47
17.40	....	....	....	17.40
945.35	476.19	75.00	....	1,496.54
406.46	....	....	....	406.46
....	....	....	....	15,476.21
....	....	....	363.00	363.00

TABLE 2: *Expenditures of the International Health Board for the*

ACTIVITY, STATE, AND COUNTRY	July 1, 1913 Dec. 31, 1914	1915	1916	1917
COUNTY HEALTH WORK[1]	$........	$........	$........	$182.95
Alabama..........	....	....	....	....
Florida...........	....	....	....	....
Georgia...........	....	....	....	....
Kansas...........	....	....	....	....
Kentucky.........	....	....	....	....
Louisiana.........	....	....	....	....
Maryland.........	....	....	....	182.95
Mississippi........	....	....	....	....
Missouri..........	....	....	....	....
New Mexico.......	....	....	....	....
North Carolina....	....	....	....	....
South Carolina.....	....	....	....	....
Tennessee.........	....	....	....	....
Texas............	....	....	....	....
Virginia..........	....	....	....	....
West Virginia......	....	....	....	....
Administration.....	....	....	....	....
MALARIA CONTROL.....	....	....	54,496.97	39,978.58
Southern States:				
Alabama......	....	....	....	....
Arkansas......	....	....	11,104.58	4,276.23
Georgia.......	....	....	....	....
Louisiana.....	....	....	....	....
Mississippi....	....	....	43,392.39	35,702.35
Missouri......	....	....	....	....
North Carolina	....	....	....	....
South Carolina	....	....	....	....
Tennessee.....	....	....	....	....
Texas........	....	....	....	....
Virginia.......	....	....	....	....
Administration	....	....	....	....
Foreign Countries:				
Ecuador......	....	....	....	....
Argentina.....	....	....	....	....
Brazil........	....	....	....	....
Nicaragua.....	....	....	....	....
Porto Rico....	....	....	....	....
Miscellaneous:				
Conference of Malaria Workers.....	....	....	....	....

[1] In September, 1917, the hookworm work in the Southern States began to be absorbed in the
being longer in some states than in others, it was not possible to announce until the end of 1920
regular functions, responsibility for all efforts directed toward the relief and control of hookworm

Years 1913–1914 to 1921, Inclusive, Covering All Activities—Cont'd

1918	1919	1920	1921	Total
$2,494.53	**$2,439.25**	**$8,182.77**	**$167,765.19**	**$181,064.69**
....	....	....	18,231.35	18,231.35
....	....	....	237.75	237.75
....	....	....	4,338.17	4,338.17
....	....	4,494.00	6,316.99	10,810.99
....	....	......	16,316.41	16,316.41
....	....	....	5,618.28	5,618.28
2,494.53	2,264.25	....	1,762.59	6,704.32
....	....	....	15,652.72	15,652.72
....	....	....	600.00	600.00
....	....	957.04	10,837.52	11,794.56
....	....	....	14,413.38	14,413.38
....	....	....	17,651.97	17,651.97
....	....	....	14,686.42	14,686.42
....	....	....	12,765.65	12,765.64
....	....	....	13,972.74	13,972.74
....	175.00	2,731.73	4,164.56	7,071.29
....	....	....	10,198.70	10,198.70
26,489.29	**34,965.08**	**133,929.02**	**150,551.39**	**440,410.33**
....	....	8,906.92	7,650.06	16,556.98
4,749.02	13,505.66	7,048.90	4,777.15	45,461.54
....	....	1,230.86	....	1,230.86
....	....	30,699.94	22,929.88	53,629.82
21,740.27	21,167.37	27,537.43	21,185.61	170,725.42
....	....	....	1,471.37	1,471.37
....	....	7,526.13	18,676.30	26,202.43
....	....	13,942.74	13,321.90	27,264.64
....	....	1,969.94	1,512.56	3,482.50
....	....	11,472.34	10,347.23	21,819.57
....	....	5,284.84	831.65	6,116.49
....	....	6,032.20	10,198.68	16,230.88
....	....	4,595.59	....	4,595.59
....	....	....	5,661.02	5,661.02
....	292.05	....	....	292.05
....	....	425.66	6,662.51	7,088.17
....	....	5,445.18	24,914.84	30,360.02
:......	....	1,810.35	245.00	2,055.35

programs of the rapidly developing county departments of health. The period of transition that in all the states the county health departments would henceforth assume as one of their and other soil-borne diseases.

TABLE 2: *Expenditures of the International Health Board for the*

Activity, State, and Country	July 1, 1913 Dec. 31, 1914	1915	1916	1917
MALARIA CONTROL—*Continued*				
Miscellaneous—*Cont'd*				
Study of Source of Blood Meals of Anopheles Mosquitoes..	$........	$........	$........	$........
YELLOW FEVER CONTROL	....	....	**41,863.17**	**9,344.03**
Yellow Fever Commission..........	....	....	41,863.17	7,727.74
East Coast of Brazil and Caribbean...	....	....	....	1,616.29
Brazil............	....	....	....	....
Ecuador..........	....	....	....	....
Guatemala........	....	....	....	....
Mexico and Central America........	....	....	....	....
Peru............	....	....	....	....
Salvador..........	....	....	....	....
Epidemic Work....	....	....	....	....
TUBERCULOSIS IN FRANCE............	....		....	**51,856.24**
Inauguration of Work..........	....	....	....	18,671.74
Department of Organization.......	....	....	....	....
Public Health Division...........	....	....	....	....
Central Administration...........	....	....	....	18,292.10
Educational Division...........	....	....	....	5,316.39
Medical Division...	....	....	....	9,576.01
Contingent Fund...	....	....	....	....
PUBLIC HEALTH EDUCATION...........	....	....	**9,256.74**	**12,376.63**
Department of Hygiene, São Paulo .	....	....	....	179.59
Institute of Hygiene, Czechoslovakia...	....	....	....	....
Public Health Institutes.........	....	....	....	....
Fellowships........	....	....	....	971.85
Adviser in Medical Education.......	....	....	....	11,225.19

Years 1913–1914 to 1921, Inclusive, Covering All Activities—Cont'd

1918	1919	1920	1921	Total
$........	$........	$........	$165.63	$165.63
46,639.17	**94,526.42**	**139,757.40**	**239,057.53**	**571,187.72**
....	44,271.12	83,717.13	....	177,579.16
2,897.97	....	....	....	4,514.26
....	....	....	461.30	461.30
29,473.98	48,396.77	28,574.98	1,698.06	108,143.79
14,267.22	967.82	....	....	15,235.04
....	....	....	156,562.54	156,562.54
....	....	....	80,335.63	80,335.63
....	890.71	3,926.26	....	4,816.97
....	....	23,539.03	....	23,539.03
433,030.43	**602,775.78**	**518,013.51**	**359,540.31**	**1,965,216.27**
....	....	....	....	18,671.74
....	....	139,364.76	47,281.28	186,646.04
....	....	76,191.46	101,473.08	177,664.54
80,037.65	72,394.12	86,310.57	89,575.04	346,609.48
85,755.19	141,053.34	135,920.64	79,839.90	447,885.46
267,237.59	389,328.32	80,226.08	40,621.01	786,989.01
....	....	....	750.00	750.00
36,642.82	**38,367.71**	**68,373.54**	**89,094.44**	**254,111.88**
32,788.84	23,582.57	29,929.01	24,727.16	111,207.17
....	....	....	204.51	204.51
....	....	....	3,466.64	3,466.64
2,353.98	13,118.47	38,409.84	60,696.13	115,550.27
1,500.00	1,666.67	....	....	14,391.86

TABLE 2: *Expenditures of the International Health Board for the*

Activity, State, and Country	July 1, 1913 Dec. 31, 1914	1915	1916	1917
Public Health Education—*Continued*				
Medical Commission to Brazil[2]	$........	$........	$9,256.74	$........
Study of Teaching of Hygiene and Public Health in Medical Schools......	....	....	....	....
Public Health Laboratory Service.......	....	....	....	....
United States:				
Kansas.......	....	....	....	....
Foreign:				
Guatemala....	....	....	....	....
Nicaragua.....	....	....	....	....
Salvador......	....	....	....	....
Administration.....	....	....	....	....
Miscellaneous.......	**15,138.35**	**15,057.65**	**27,628.35**	**18,191.76**
Czechoslovakia Public Health Work..	....	....	....	....
Paris Conference on International Nomenclature of Causes of Death.	....	....	....	....
Compilation of Mining Sanitary Code	....	....	....	....
Survey Public Health Administration in Massachusetts........	....	....	....	....
Investigation of Powdered Milk..	....	....	....	....
Medical Commission to Brazil[2]	....	....	9,256.73	....
Visit of Brazilian Scientists to United States....	....	....	....	....
British Advisory Committee......	2,561.36	....	....	....
Field Equipment and Supplies.....	742.88	....	....	2,464.68
Surveys and Exhibits	11,421.16	15,057.65	18,371.62	13,854.57
Pamphlets and Charts..........	847.86	....	....	1,335.66
Library...........	1,844.12	....	....	....
Express, Freight, and Exchange....	....	....	....	536.85
Refunds which could not be credited direct to budget .	−(2,279.03)	....	....	....

[2] Represents one half total expenditure.

Years 1913–1914 to 1921, Inclusive, Covering All Activities—Cont'd

1918	1919	1920	1921	Total
$........	$........	$........	$........	$9,256.74
....	....	34.69	....	34.69
....	....	....	**16,109.70**	**16,109.70**
....	....	....	2,539.88	2,539.88
....	....	....	307.50	307.50
....	....	....	85.18	85.18
....	....	....	984.34	984.34
....	....	....	12,192.80	12,192.80
23,034.17	**46,901.63**	**51,248.30**	**59,652.90**	**256,853.11**
....	....	12,708.81	20,736.31	33,445.12
....	....	615.30	....	615.30
....	....	....	125.98	125.98
....	26.09	1,467.27	....	1,493.36
....	....	500.00	....	500.00
....	....	....	....	9,256.73
....	....	....	7,660.12	7,660.12
....	....	....	....	2,561.36
3,000.00	23,434.94	5,996.96	4,982.25	40,621.71
14,970.85	16,870.71	23,528.78	13,437.76	127,513.10
3,999.49	5,499.50	5,873.33	10,153.44	27,709.28
....	....	....	....	1,844.12
1,063.83	1,070.39	557.85	2,557.04	5,785.96
....	....	....	....	–(2,279.03)

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